Appendix A

Comments and Responses

Appendix B

Project Map

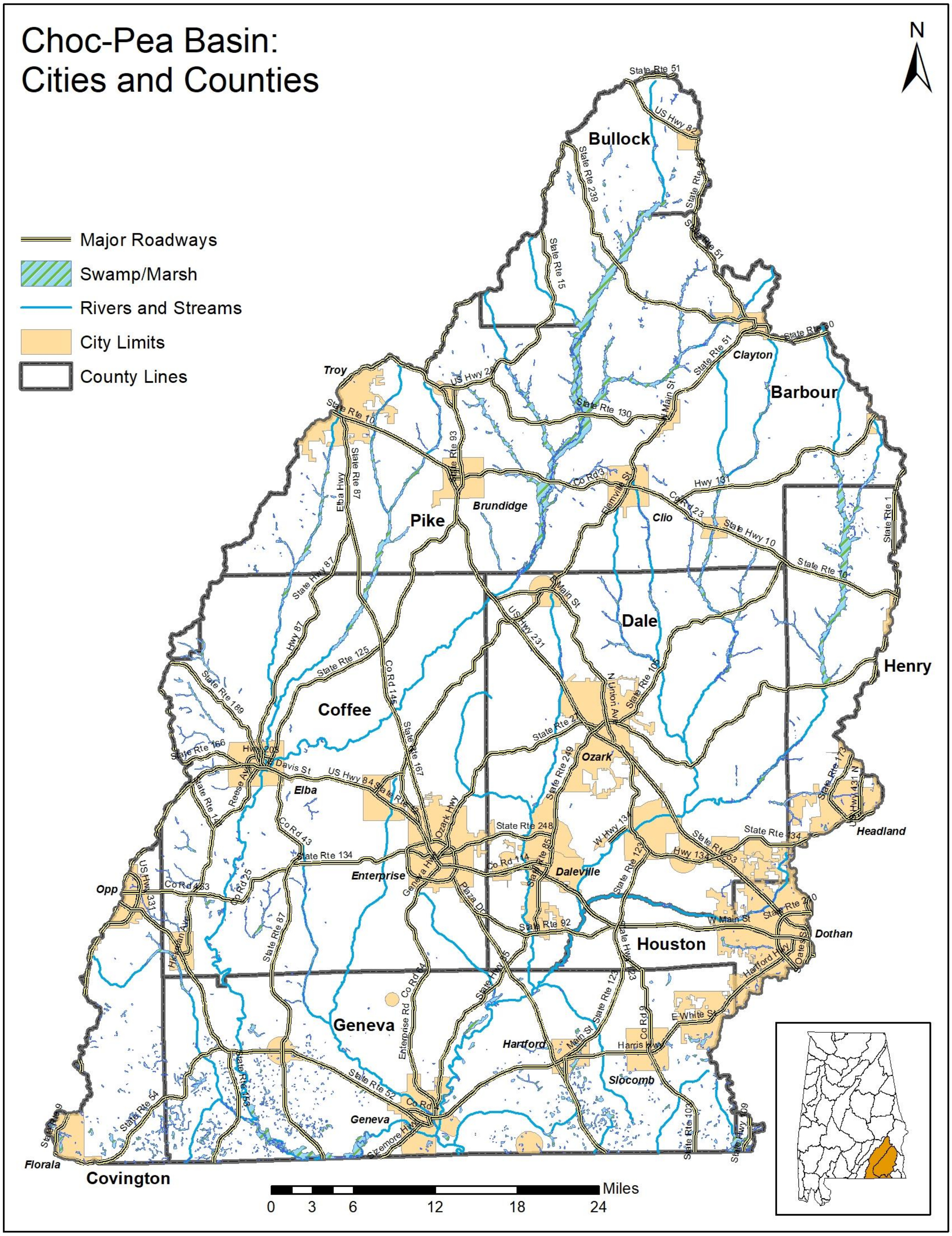

Figure B-1: Basin Project Map

Appendix C

Supporting Maps

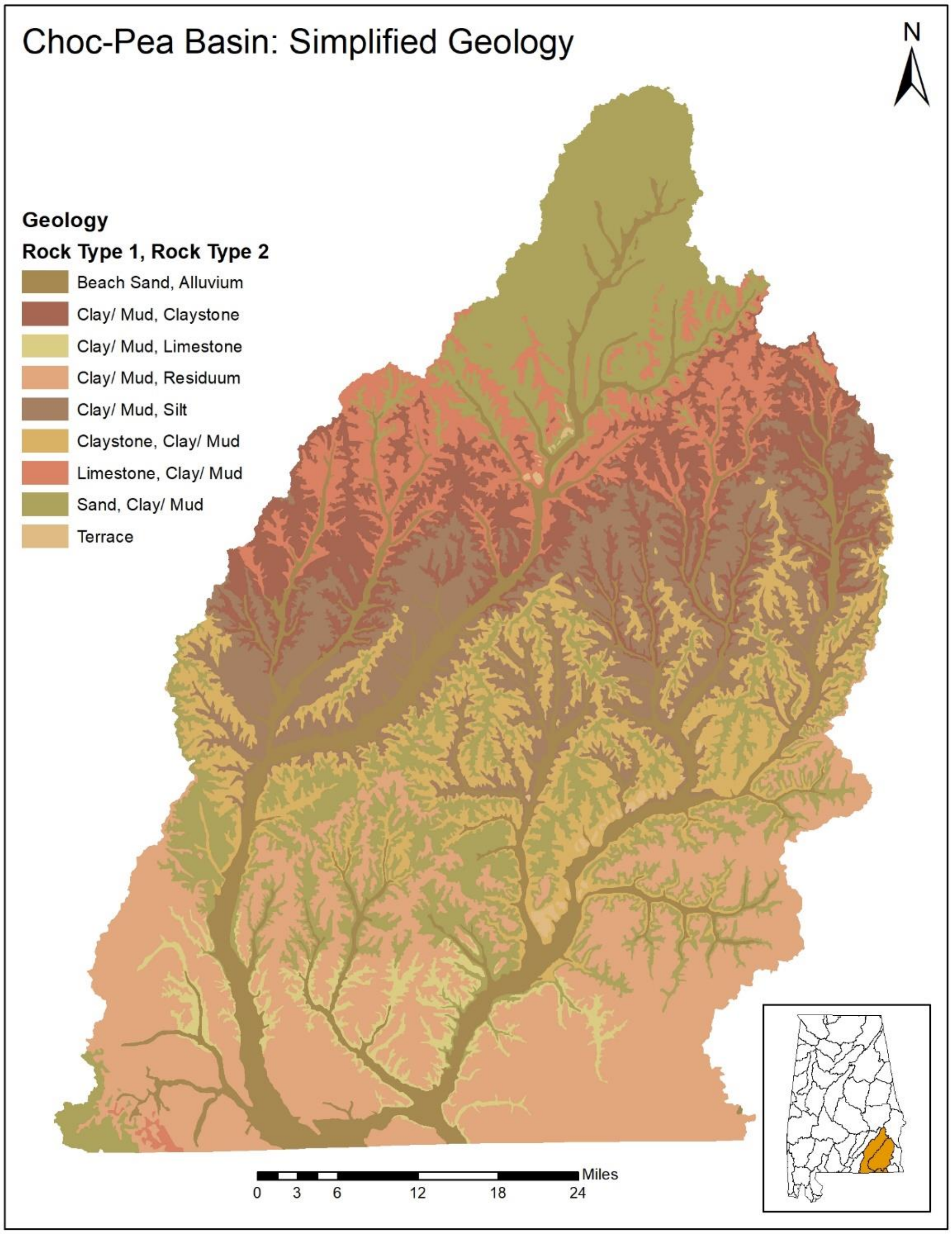

Figure C-1: Simplified Geology of the Project Area

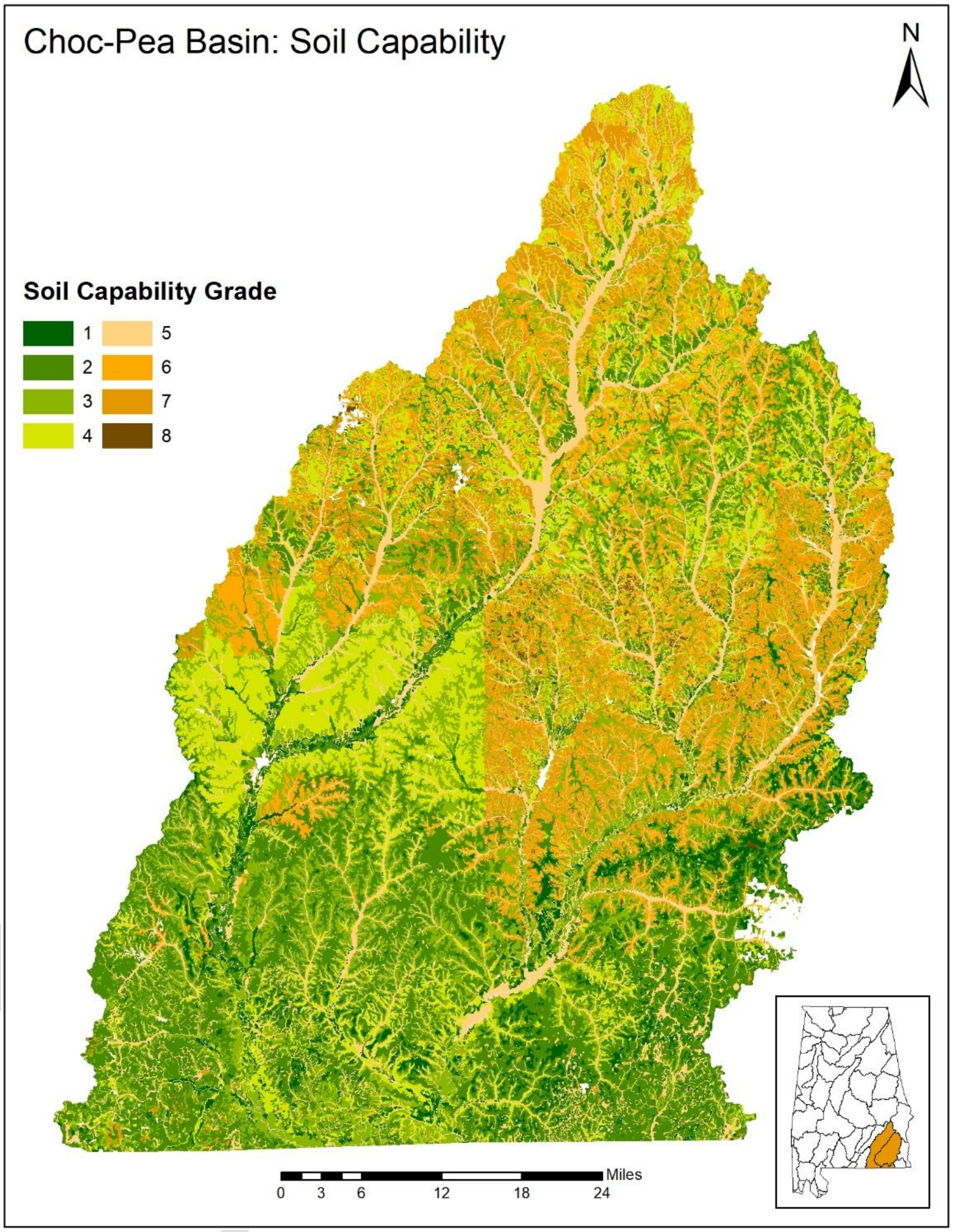

Figure C-2: Soil Capability Classification Map of the Project Area

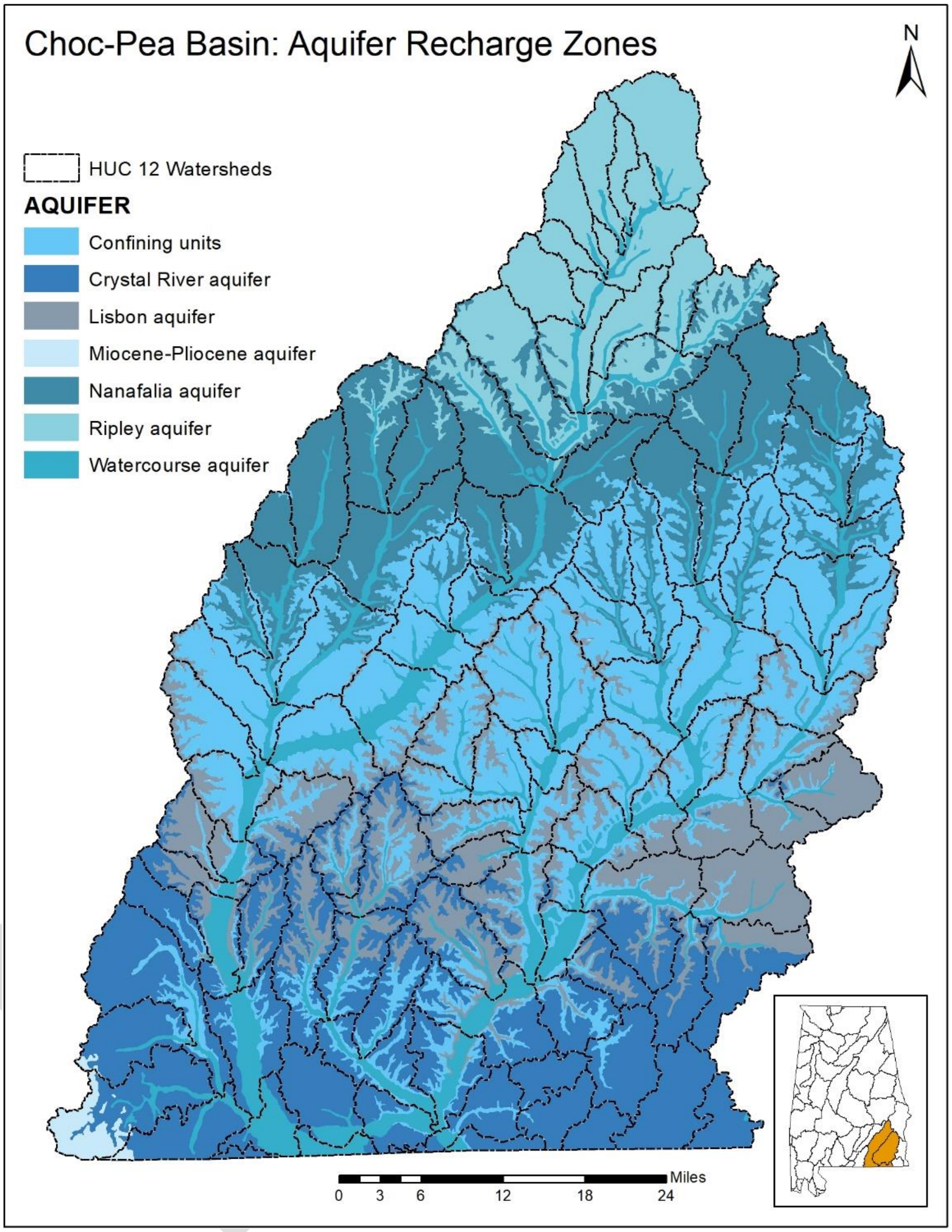

Figure C-3: Groundwater Map of the Choc-Pea Basin Project Area

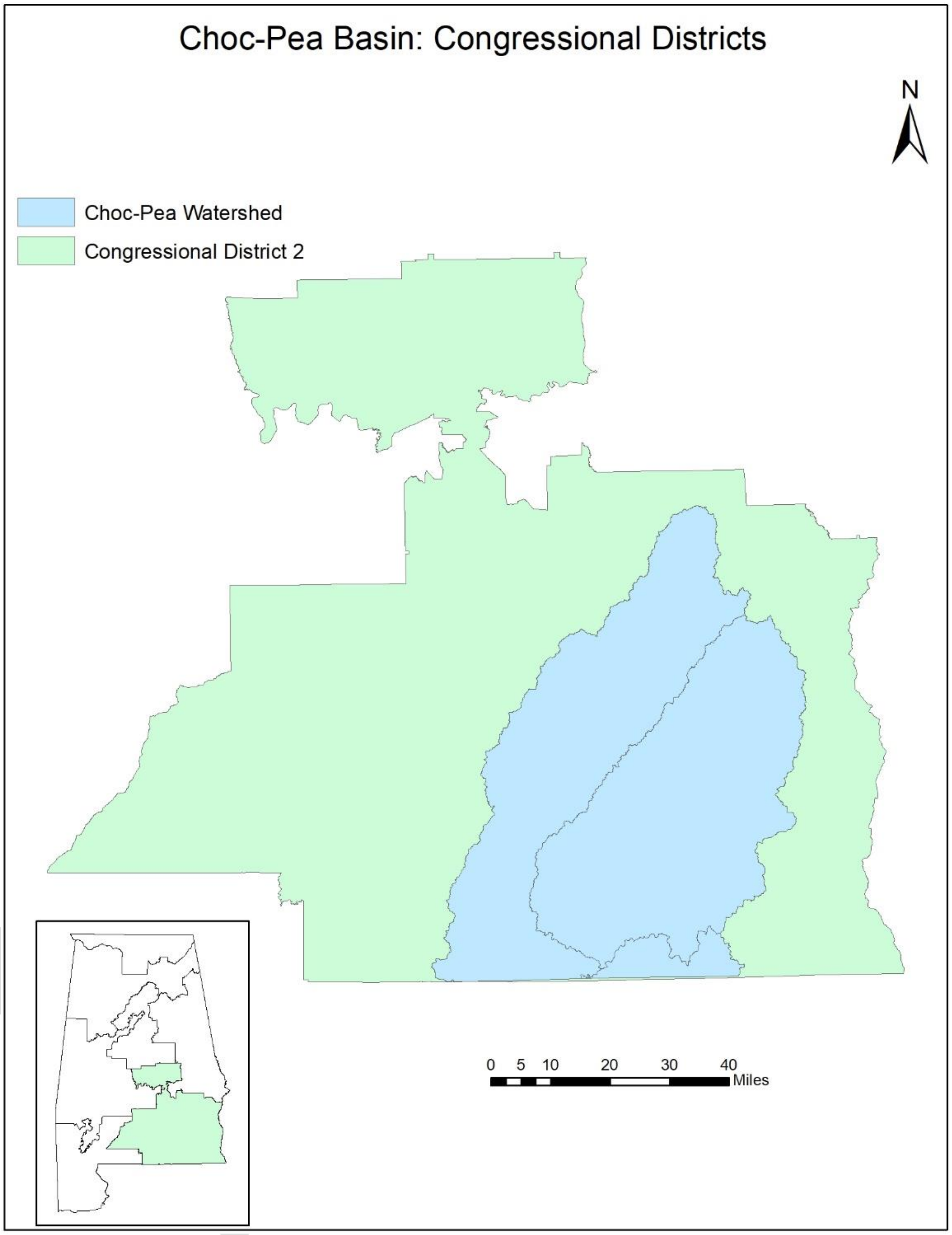

Figure C-4: Map of Congressional Districts Overlapping the Choc-Pea Basin

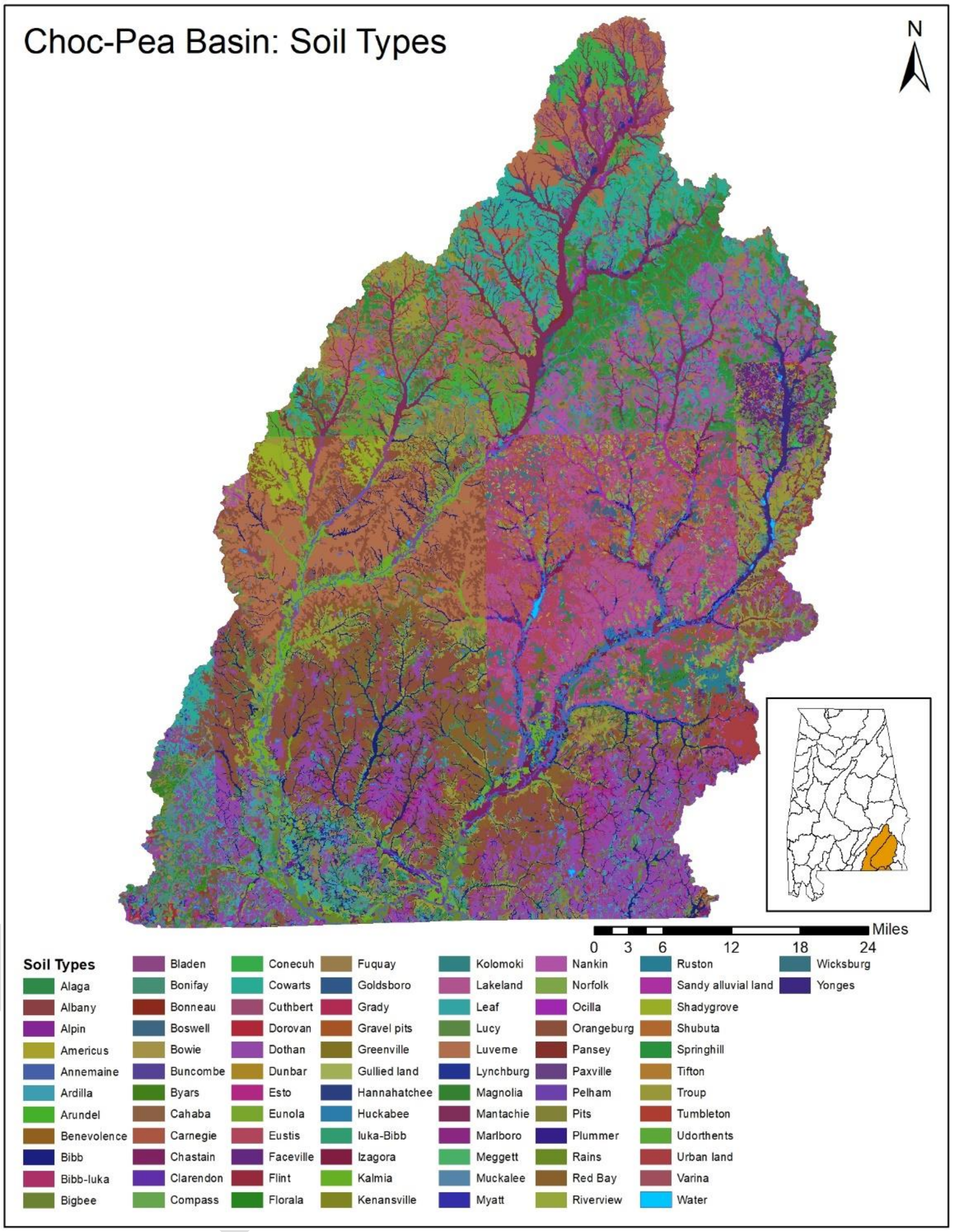

Figure C-5: Map of All Soil Types in the Project Area

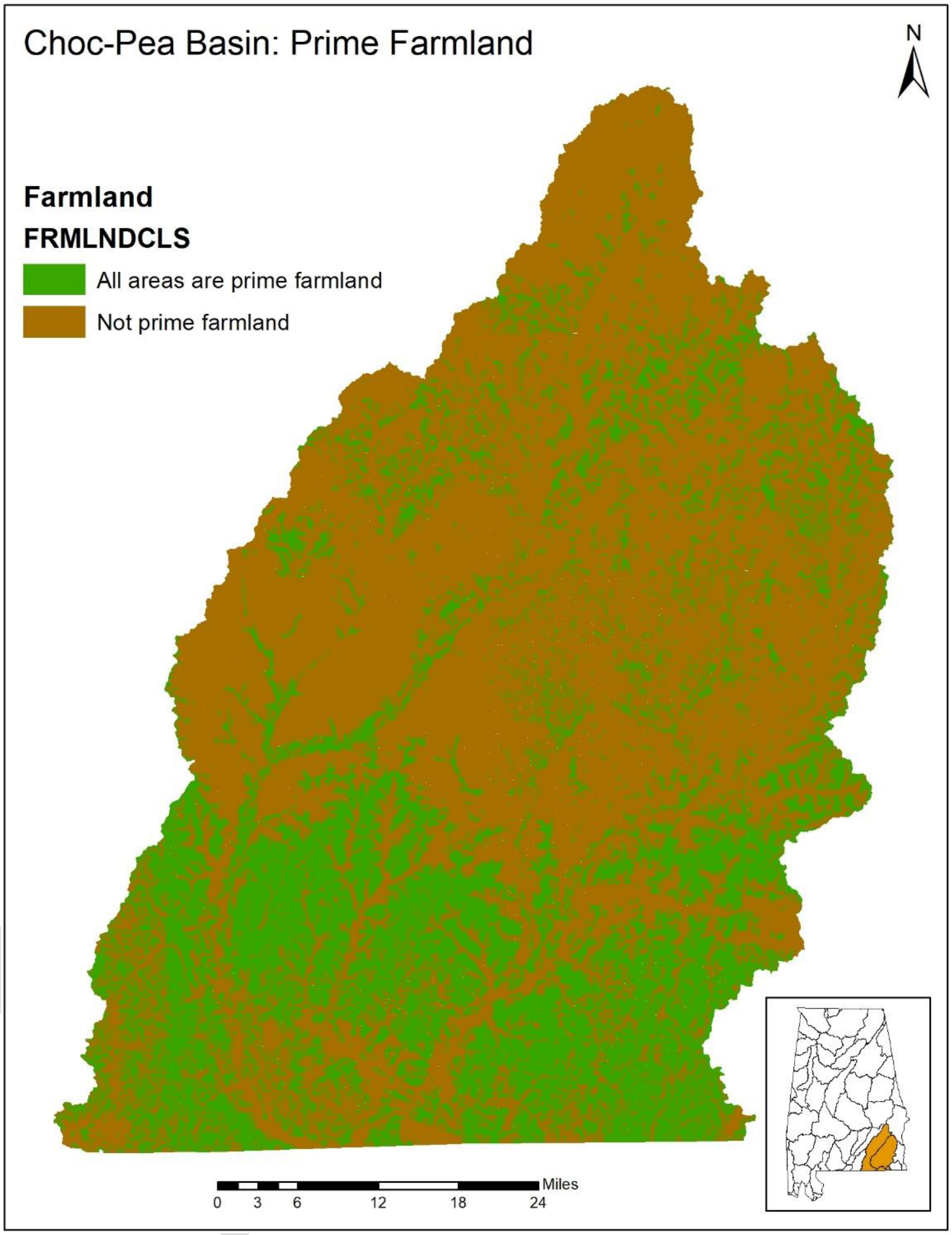

Figure C-6: Map of Prime Farmland in the Project Area

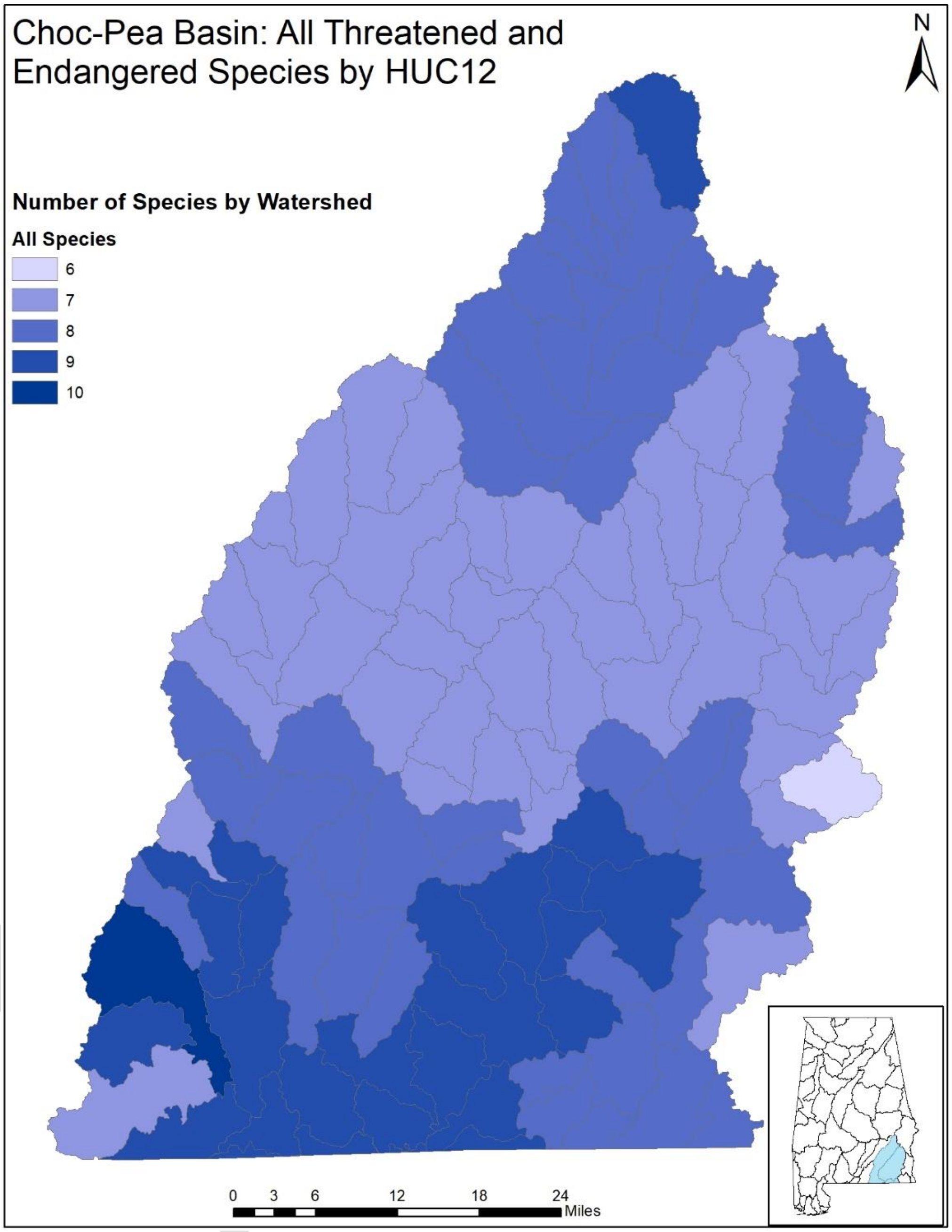

Figure C-7: Map of All T&E Species in the Project Area

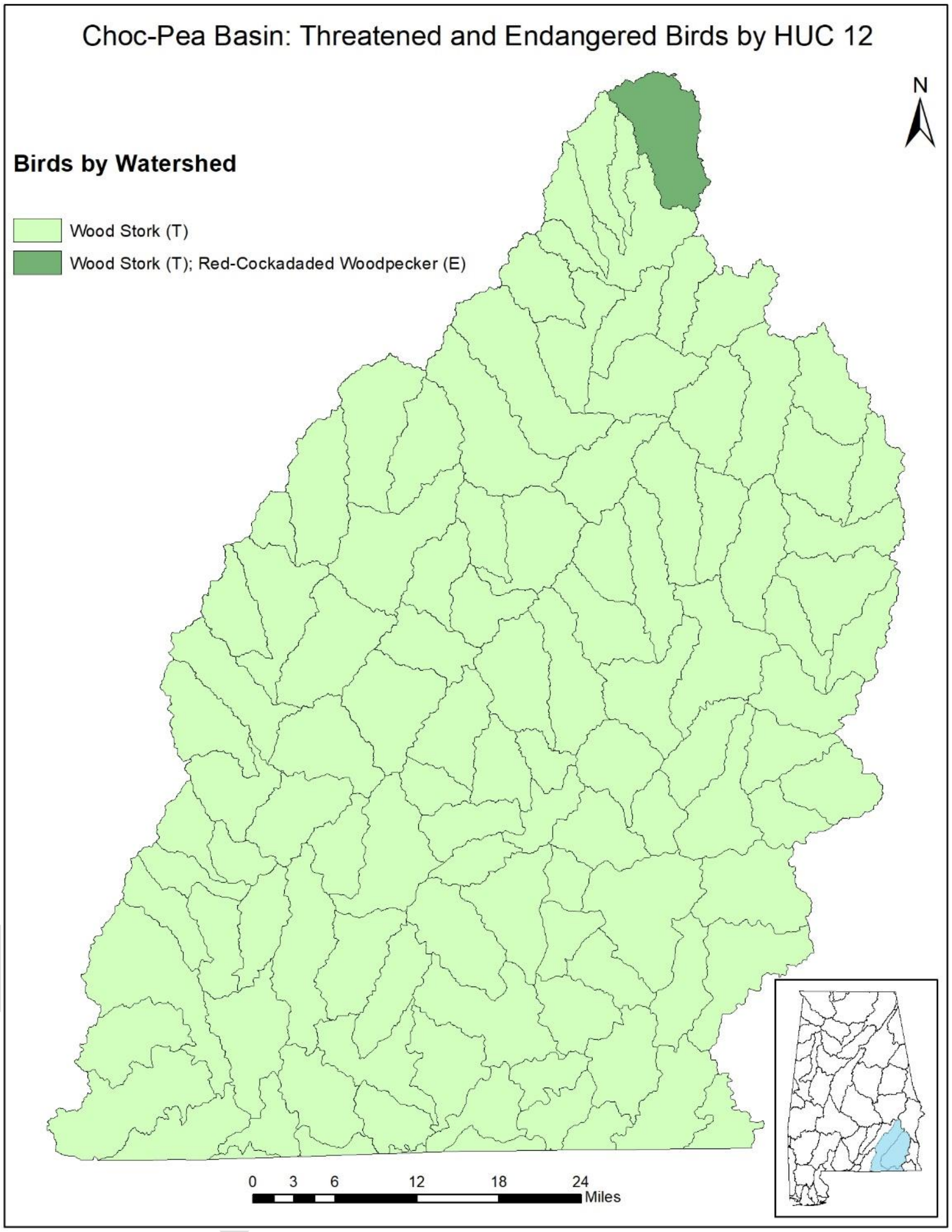

Figure C-8: Map of T&E Bird Species in the Project Area

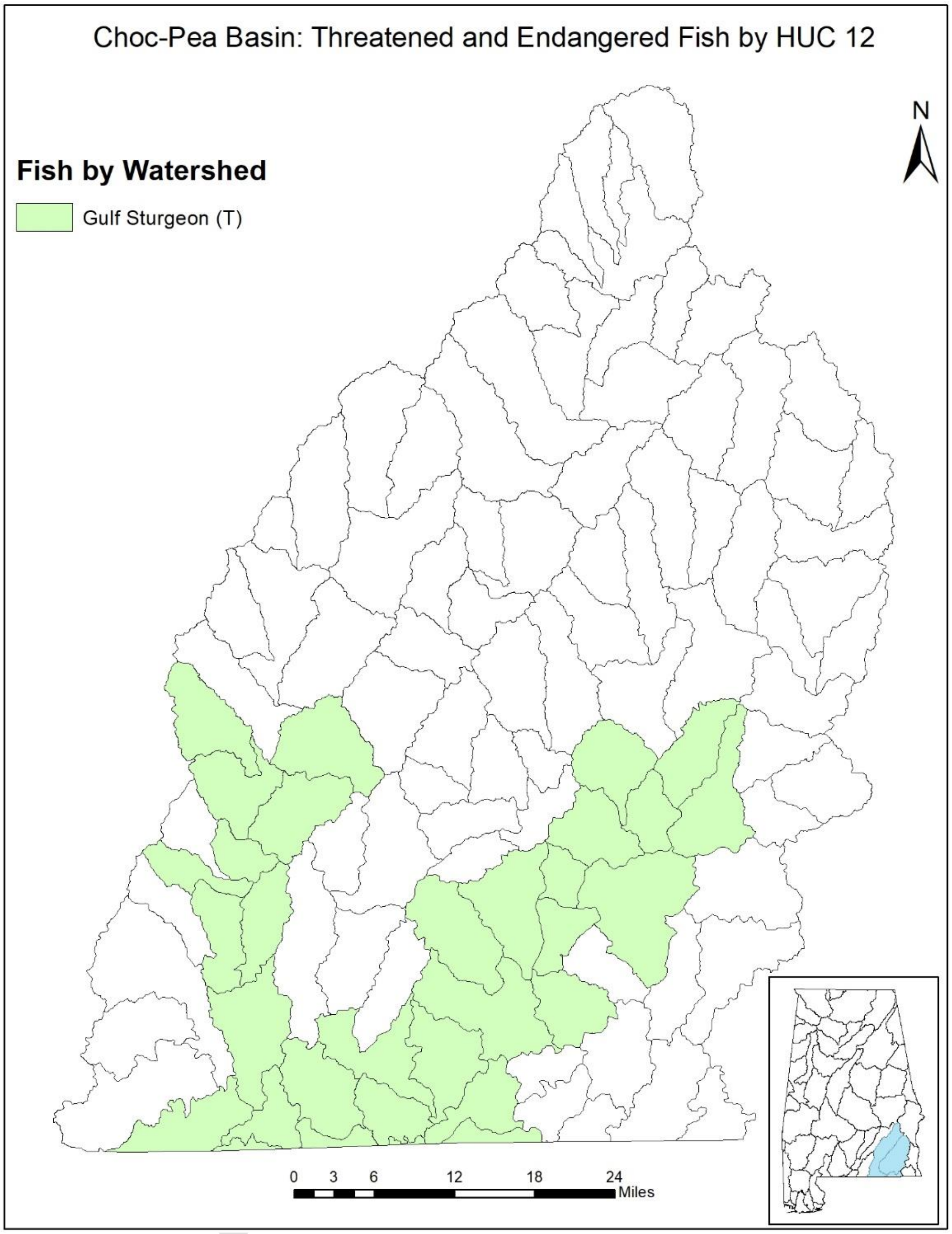

Figure C-9: Map of T&E Fish Species in the Project Area

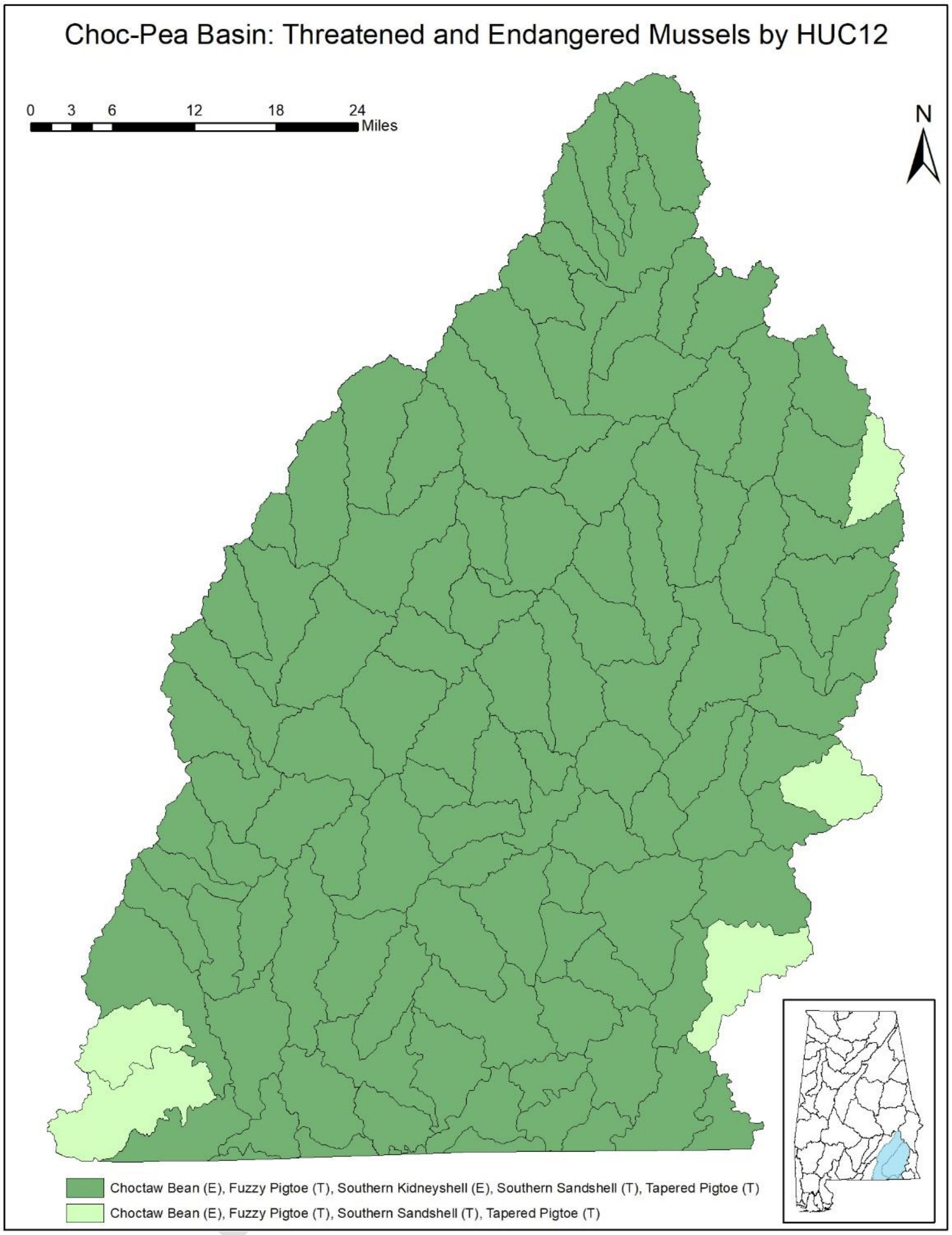

Figure C-10: Map of T&E Mussels Species in the Project Area

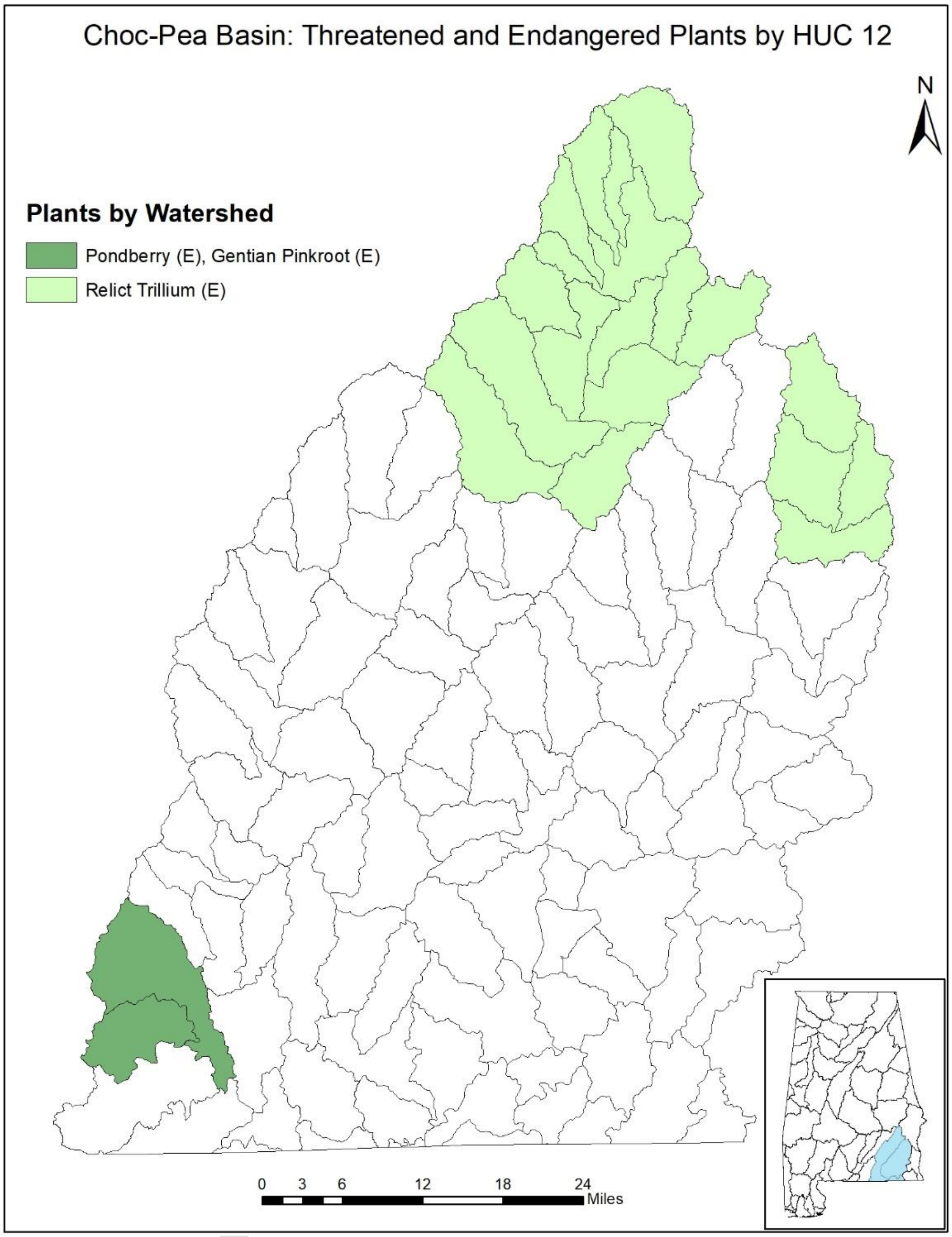

Figure C-11: Map of T&E Plant Species in the Project Area

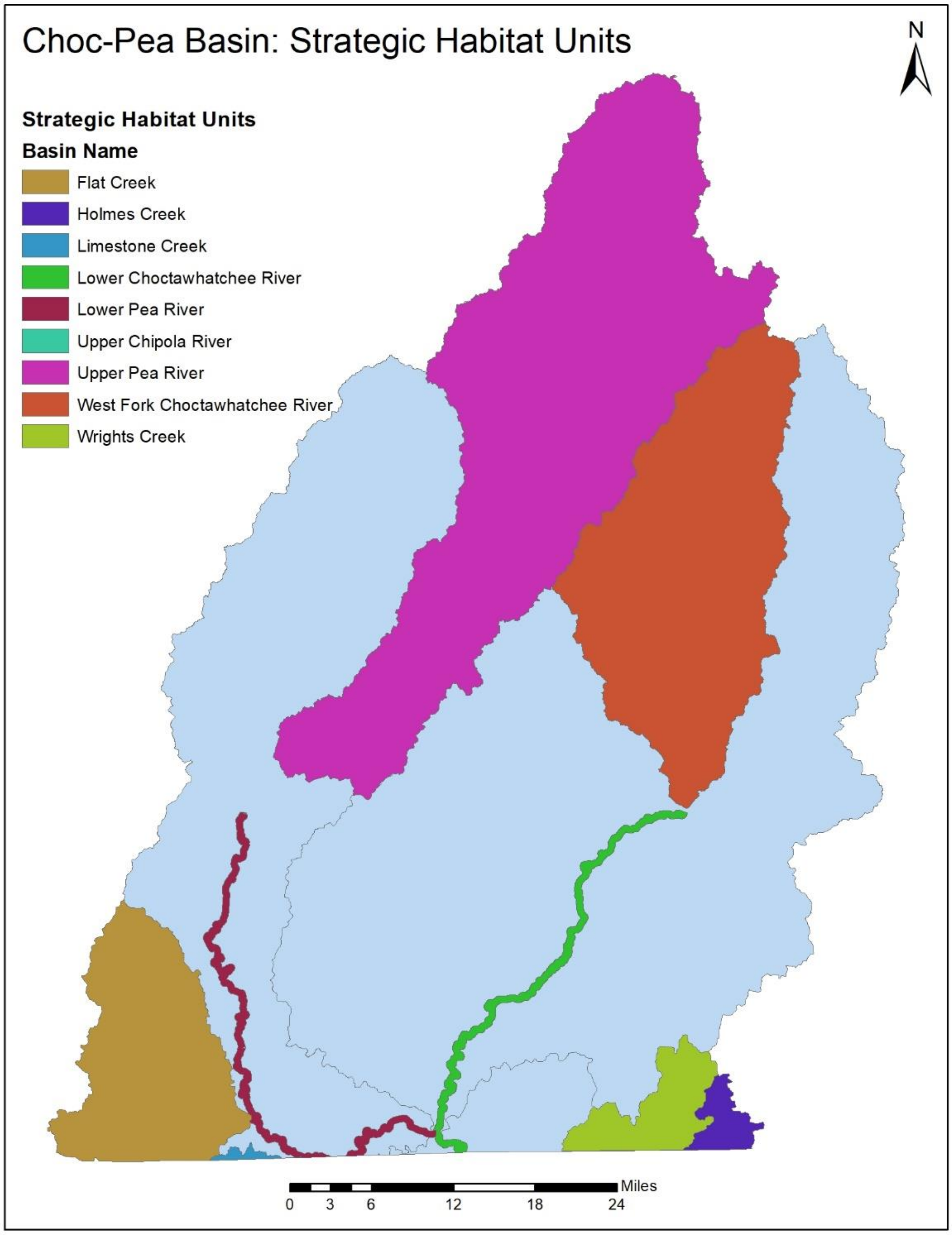

Figure C-12: Strategic Habitat Units in the Project Area

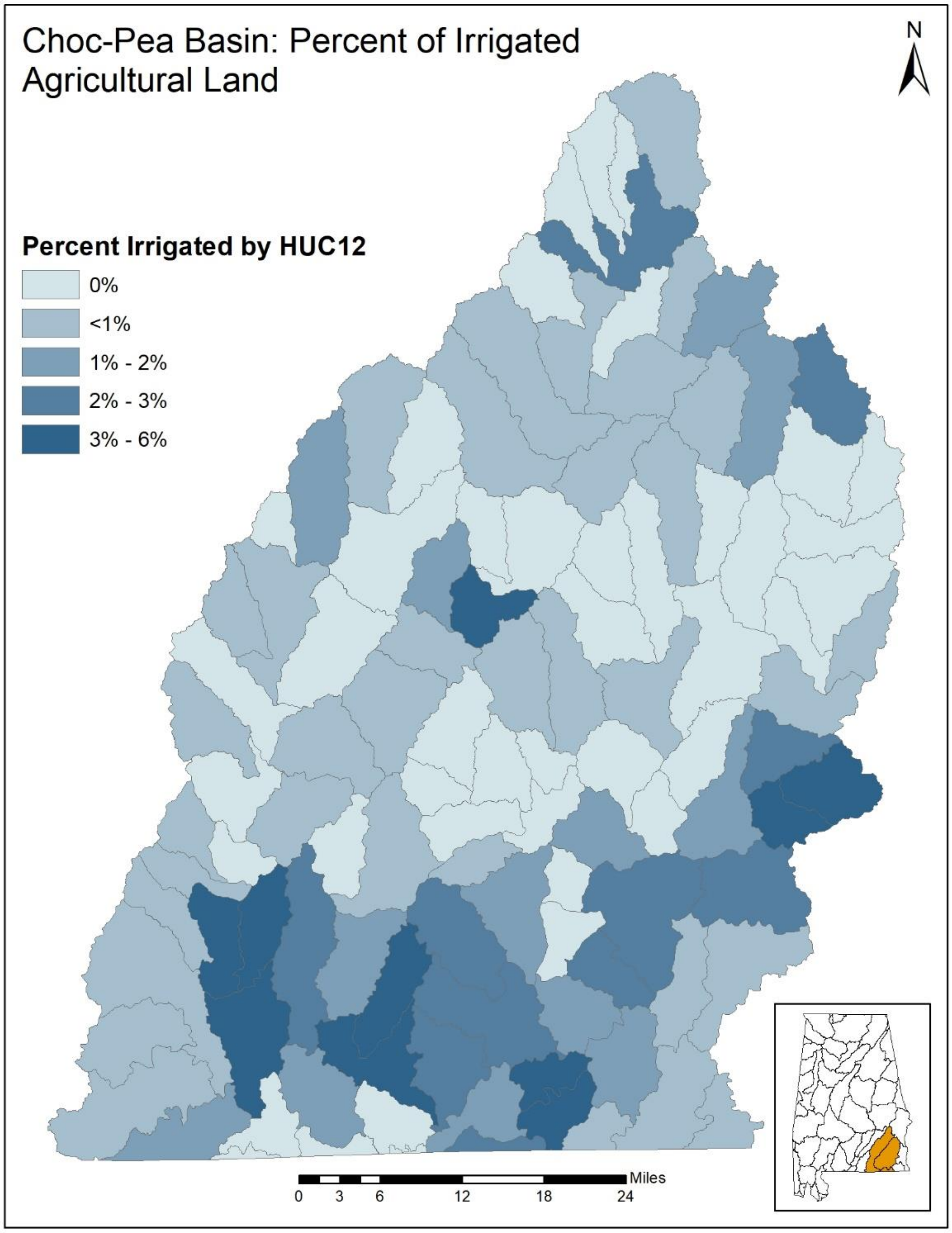

Figure C-13: Map of the Percent of Irrigated Agricultural Land by HUC-12 in the Choc-Pea Basin

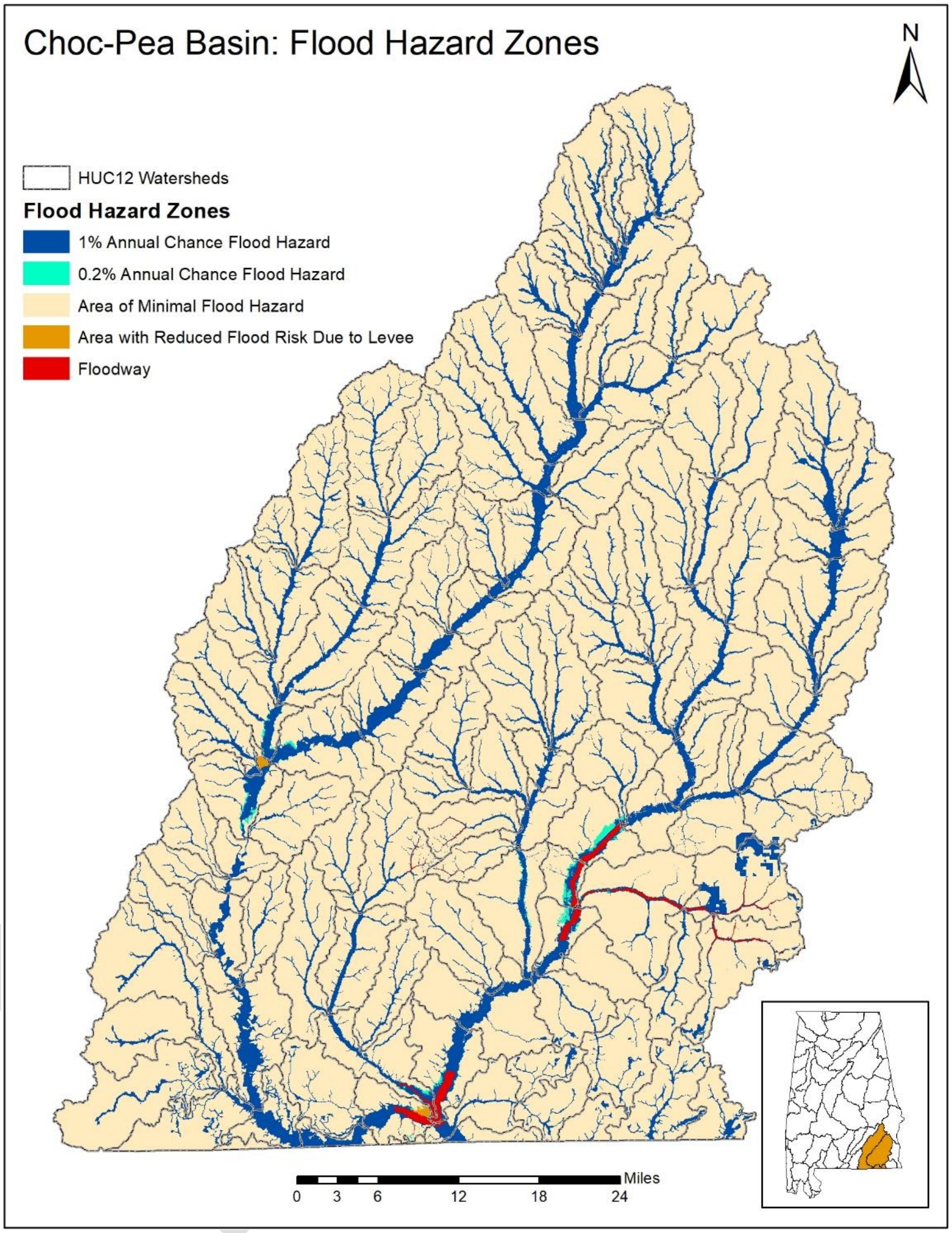

Figure C-14: Flood Hazard Zones within the Project Area

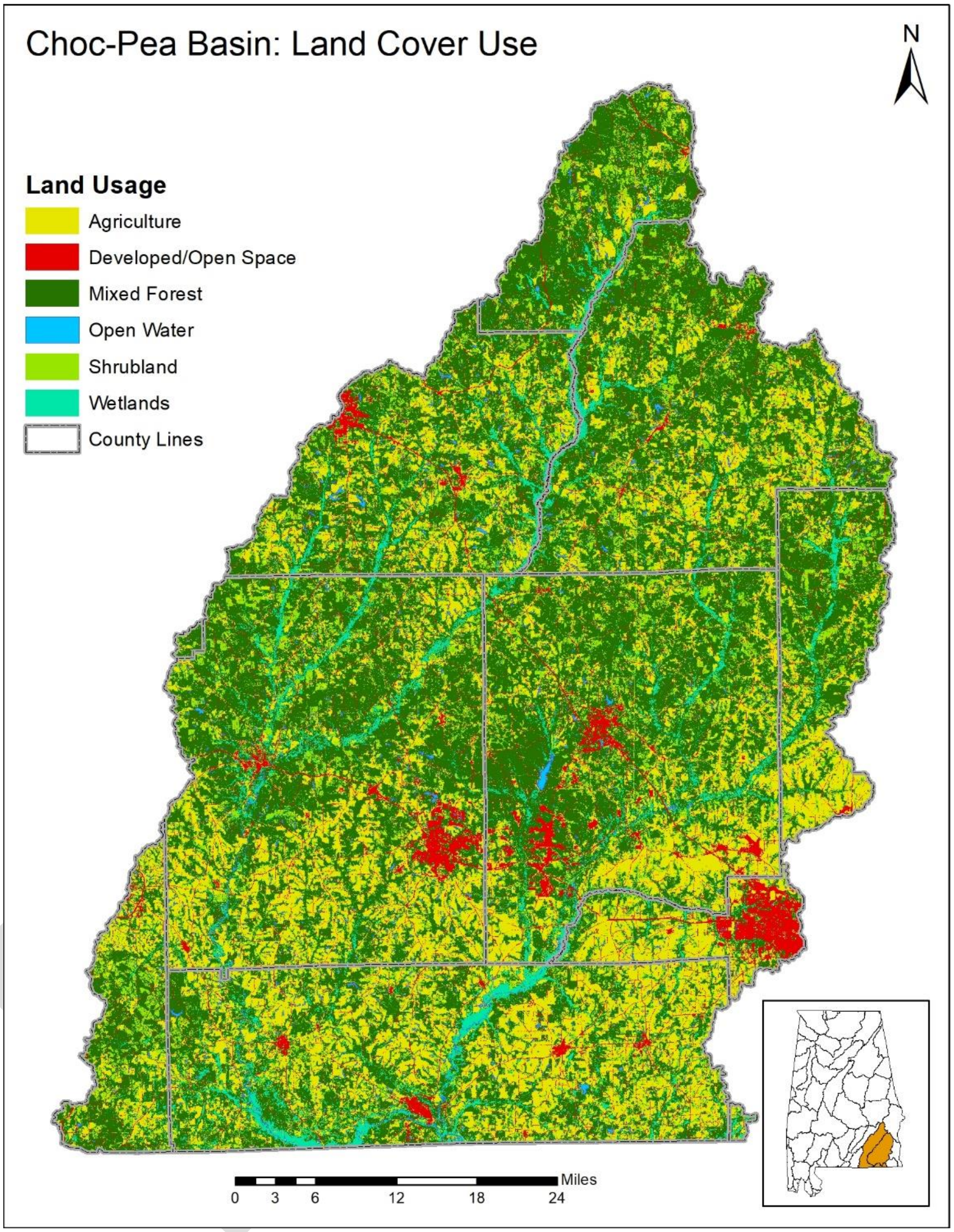

Figure C-15: Land Use in the Project Area

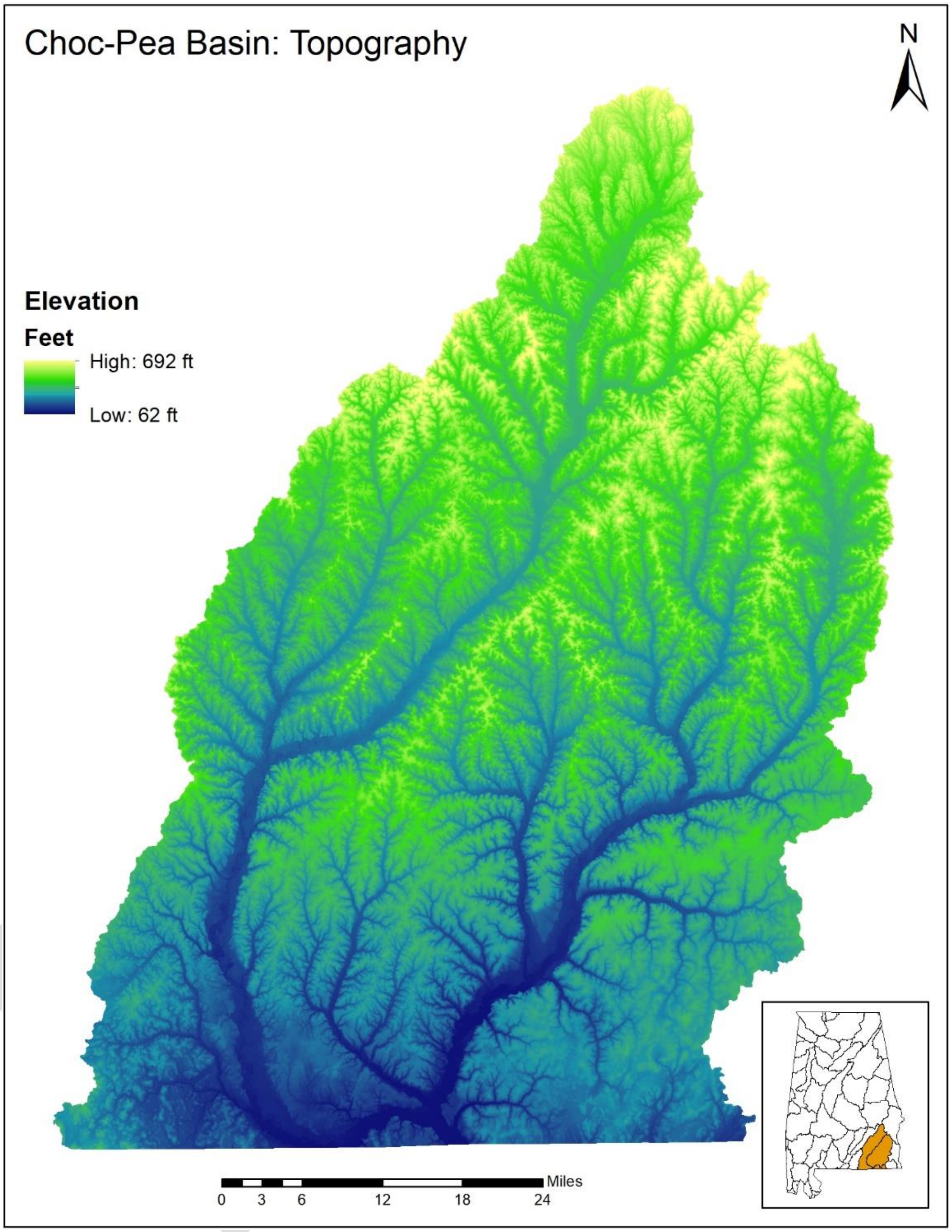

Figure C-16: Topography in the Choc-Pea Basin Project Area

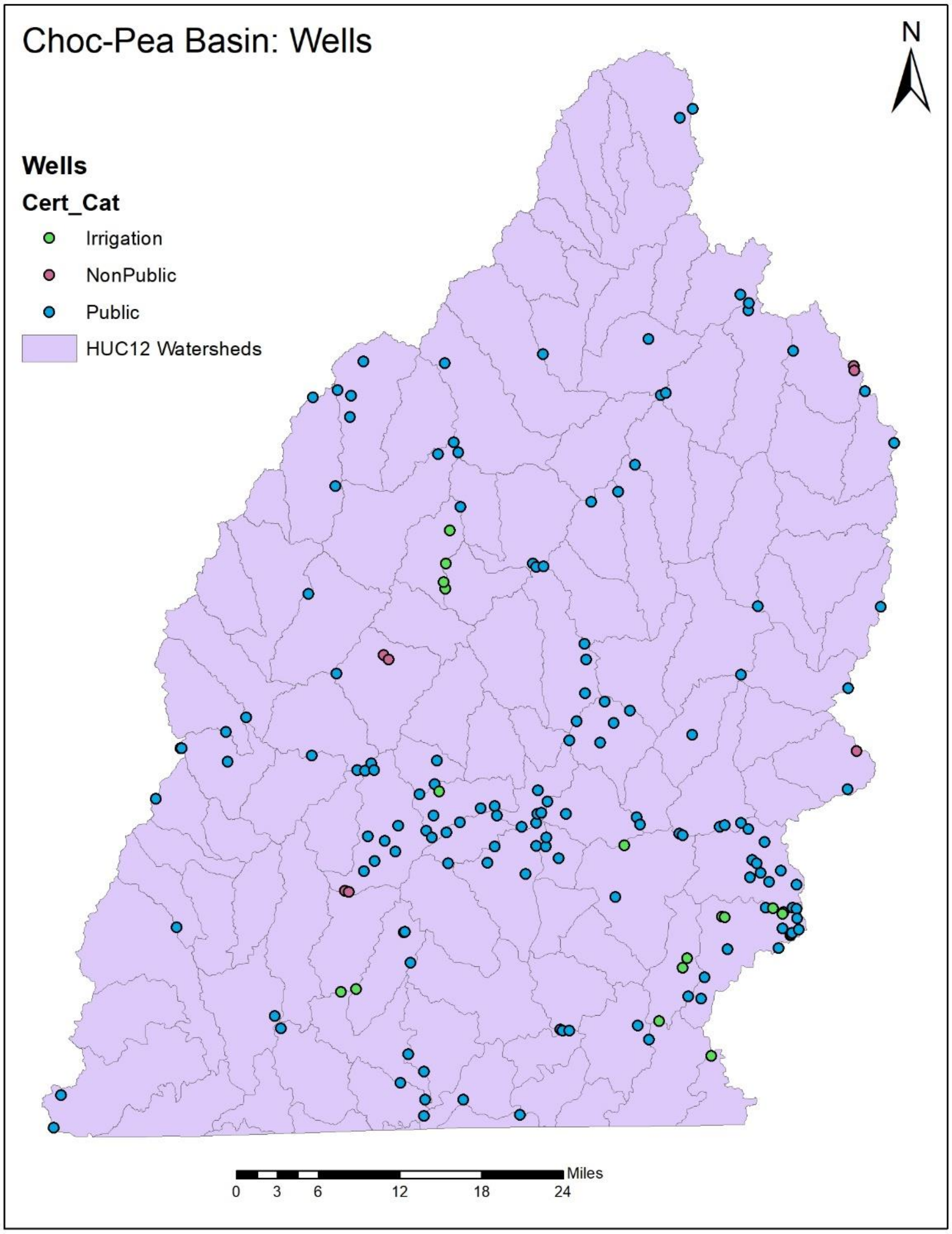

Figure C-17: Map of Wells within the Choc-Pea Basin Area

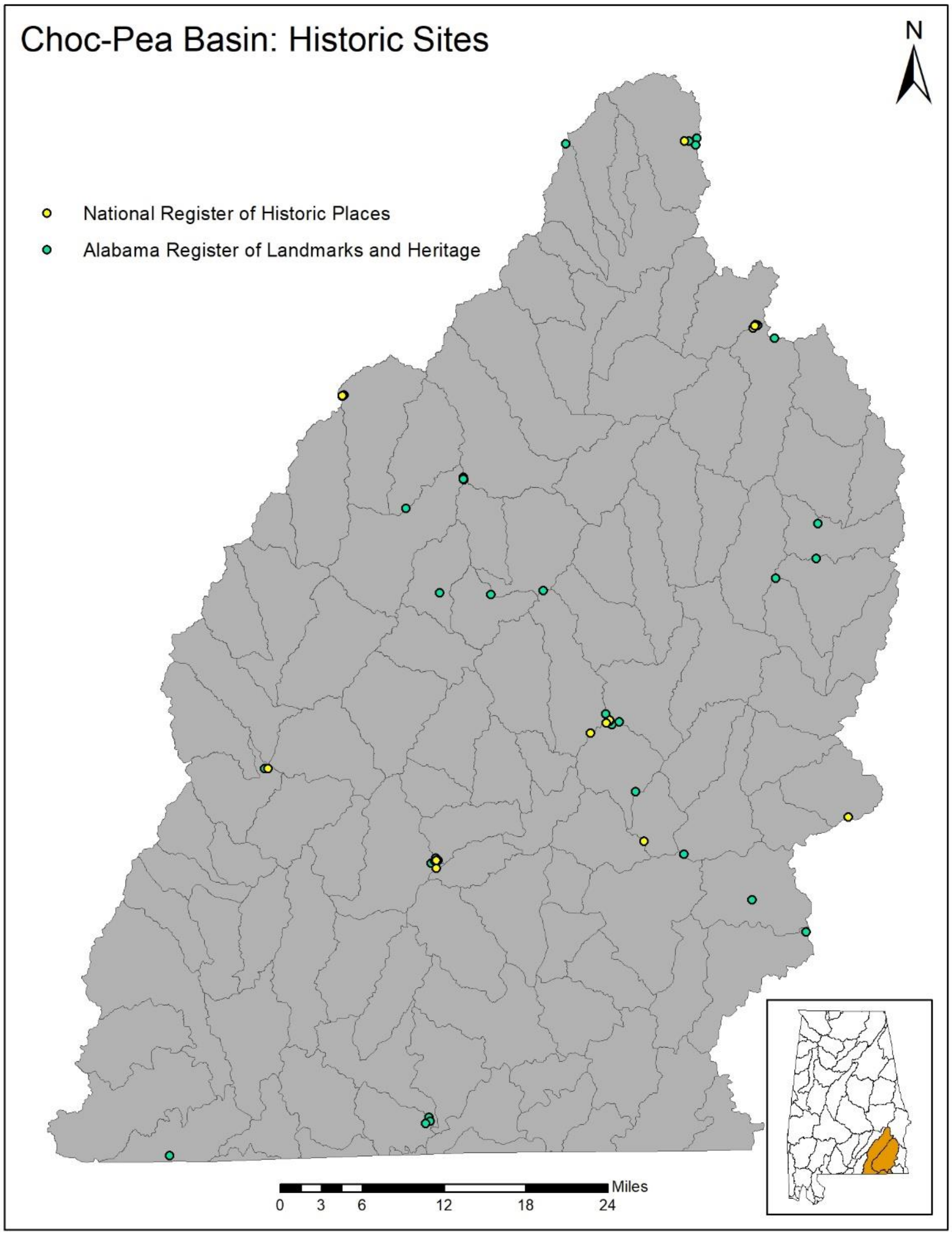

Figure C-18: Map of NRHP and ARLH Listed Resources within the Choc-Pea Basin Area

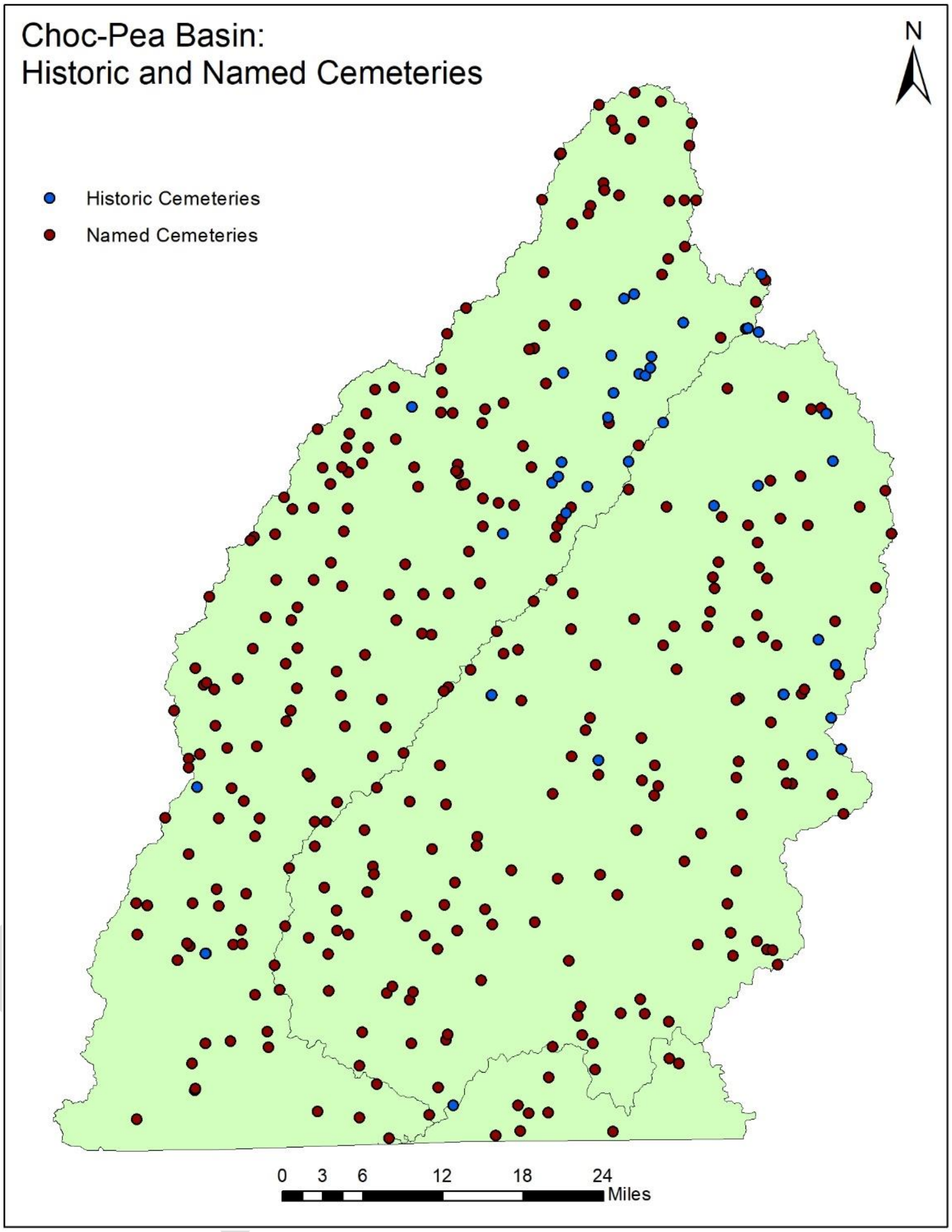

Figure C-19: Map of Historic and Named Cemeteries within the Choc-Pea Basin Area

Appendix D

Investigations and Analysis Reports

D.1 National Economic Development Analysis

National Economic Development Analysis

D.1 Benefits and Costs

This section provides a National Economic Development (NED) analysis that evaluates the costs and benefits of the Preferred Alternative of increasing on-farm irrigation systems compared to the No-Action Alternative (referred to as No-Action). The analysis uses Natural Resources Conservation Service guidelines for the evaluation of NED benefits as outlined in the NRCS Natural Resources Economics Handbook and the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.

All economic benefits and costs are provided in 2020 dollars and have been discounted and amortized to average annualized values using the 2020 federal water resources planning rate of 2.75 percent.

1.1. Analysis Parameters

This section describes the general parameters of the analysis, including the project purpose, funding sources, the evaluation unit, the project implementation timeline, the period of analysis, and on-farm irrigation adoption rates.

1.1.1. Project Purpose

The purpose of this project is to minimize damage to plant health and vigor, improve soil health, and protect basin water quality all of which are resources of concern associated with rainfed farming in Alabama. Climate change projections vary from more precipitation arriving in extreme, less frequent storms to less precipitation accompanied by increased temperatures. The uncertainty of climate model predictions supports the need for a reliable source of water, as risks to land, labor, and resources occur. This project is needed to address untimely and inadequate precipitation, which results in less biomass development and impacts to plant health and vigor. Reduced biomass limits the incorporation of critical organic matter into the soil, reducing soil health. Nutrient use efficiency is decreased when plant health and vigor is impacted, which increases nutrients available for export. By developing diffuse or decentralized on-farm irrigation systems suitable for the farming practices in the Choc-Pea, resilience of the agricultural resources of concern is enhanced and the risk of damages can be greatly reduced. The project would be developed such that it adheres to State and Federal law and sustainably uses water systems. Implementation of the proposed action would satisfy the PL-566 Authorized Project Purpose, Agricultural Water Management (AWM), through irrigation and agricultural water supply for the benefit of local landowners and communities.

1.1.2. Funding

Funding is expected to be provided through Public Law 83-566 funds with a cost-share from farmers. The farmer portion would be from non-federal funds.

1.1.3. Evaluation Unit

We compare the Preferred Alternative and the No-Action Alternative on the basis of additional irrigated acres due to PL 83-566 funding.

1.1.4. Project Timeline

With current funding, we estimate irrigation investment associated with the project will take place over four years. Irrigation investment will begin in year 1. From initial discussions with farmers in the Choc-Pea Basin, most interested participants already have access to ground or surface water, so the only investment would be in irrigation equipment, e.g., center pivots, etc., which can be installed and running within the first year of the project.

1.1.5. Period of Analysis

The period of analysis used is 24 years. We estimated the life of a well at 20 years with installation of 4 years. The life of a center pivot is estimated at 20 years with installation of 2 years.

This complements the 10 percent Environmental Sensitivity Scenario where at the current rate of irrigation adoption (the No-Action plan), it would take approximately 54 years to reach the hypothetical 168,975 irrigated acres within the basin area dependent upon only surface water sources based on the Irrigation Density Analysis (see Appendix D.2). The Preferred Alternative target adoption rate of 4,200 acres per year would shorten that time period to approximately 40 years to reach the hypothetical 168,975 irrigated acres. This is the first year the Environmental Sensitivity Scenario may be reached.

The period of analysis for the Environmental Sensitivity Scenario was found by dividing the Preferred Alternative target of 16,800 additional irrigated acres by the target adoption rate of 4,200 acres/year. This is the 4 years of installation. Then a center pivot lifespan of 20 years.

1.1.6. Irrigation Adoption Rates

With no plan, funds dedicated towards irrigation investment in the future are uncertain. Therefore, there are no NED costs and benefits in a future without plan. Handyside (2017) found that irrigated acreage increased at an average of 3,151 acres per year from 2006-2015 within the Choc-Pea Basin. With the plan, we project that irrigation acreage adoption will increase by forty percent (4,200 total irrigated acres per year) until available program funds are expended (approximately four years).

After 20 years, a farmer would have to reinvest in a new irrigation system (or make substantial upgrades to the old). Funds are uncertain for reinvestment, so we assume no irrigation investment associated with the project after the 20-year useful life of the irrigation system purchased with project funds.

2. Proposed Project Costs

2.1. Costs Considered and Quantified

The Operation, Maintenance, and Replacement (OM&R) costs to be borne by producer are included in the crop enterprise budgets found in Appendix D, Section 5.1, and can also be seen in the table below (Table D-1). Tables D-2, D-3, and D4 (NWPM 506.11, 506.12, 506.18, Economic Tables 1, 2, and 4) below summarize installation costs, distribution of costs, and total annual average costs for the Alternative. The subsections below provide details on the derivation of the values in the tables. Average annual costs include those associated with installation costs.

Table D-1. OM&R Costs Associated with the Well-Pivot Scenario, 2020$

Well-Pivot Scenario		
Item	**Per Acre**	**Total (130 acres)**
Pivot	$894	$116,256
Pump	$145	$18,853
Pipe	$105	$13,651
Wire	$56	$7,255
Pump Panel	$45	$5,849
Utilities	$69	$8,940
Valves, fittings	$33	$4,348
Remote	$30	$3,938
Well		$130,000
Pond (30 ac-ft)		
Total		$309,090
Total Per Acre		$2,378

The OM&R was calculated in the following manner:

The Well-pivot scenario seen above has a cost of $2,378 per acre based on a 130-acre system (NRCS, n.d.). Operating costs are estimated to be $7 per acre inch of water applied, and a total of 5-acre inches are assumed to be applied each year for each crop (G. Morata, B. Goodrich, B. Ortiz, 2019). The total cost of the 130-acre irrigation system is $309,090. Of this total cost, the cost of the well is 42 percent and the irrigation system is 58 percent.

On a per acre basis, this cost is shown as $61.33 ($20 for the well system and $41.33 for the pivot). By adding the operating cost of $35 to the repair and maintenance cost of $61.33, the annual cost is $96.33 OM&R. The cost was calculated annually for acres of irrigated project area for the period of analysis (24 years), and an NPV for OM&R was calculated. The NPV for OM&R is $22,321,894.

Table D-2. Economic Table 1-- Estimated Installation Cost, Choc-Pea Basin, Alabama, 2020$

Works of Improvement	Unit	Number			Estimated cost (dollars)[1,2,3]						
					Public Law 83-566 Funds			Other Funds			Total
		Federal Land	Non-Federal Land	Total	Federal Land NRCS	Non-Federal Land NRCS	Total	Federal Land	Non-Federal Land	Total	
Investment in Irrigation Equipment	Acres	0	16,800	16,800	$-	$23,130,026	$23,130,026	$-	$18,174,483	$18,174,483	$41,304,509
Total Project	Acres	0	16,800	16,800	$-	$23,130,026	$23,130,026	$-	$18,174,483	$18,174,483	$41,304,509

1 Price Base: 2020 dollars

2 Project cost includes 6.25% technical assistance costs

3 Assume 70% of PL 83-566 funds go towards a 50% cost-share with farmers, while 30% of PL 83-566 funds go towards a 65% cost-share with farmer. Other funds represent farmer contributions.

Table D-3. Economic Table 2- Estimated Cost Distribution Irrigation Equipment Investment, Choc-Pea Basin, Alabama, 2020$

Works of Improvement	Installation Costs-PL 83-566 Funds[1,2]			Installation Costs-Other Funds			Total
	Construction	Project Admin[3]	Total PL 83-566	Construction	Project Admin	Total Other	
Investment in Irrigation Equipment	$21,769,436	$1,360,590	$23,130,026	$18,174,483	$-	$18,174,483	$41,304,509
Total costs	$21,769,436	$1,360,590	$23,130,026	$18,174,483	$-	$18,174,483	$41,304,509

1 Price Base: 2020 dollars

2 Assume 70% of PL 83-566 funds go towards a 50% cost-share with farmers, while 30% of PL 83-566 funds go towards a 65% cost-share with farmer. Other funds represent farmer contributions.

3 Project Admin includes project administration, technical assistance costs and permitting costs.

Table D-4. Economic Table 4- Estimated Average Annual NED Costs, Choc-Pea Basin, Alabama, 2020$

Works of Improvement	Project Outlays (Amortization of Installation Costs)[1]	Project Outlays (OM&R Cost)	Other Direct Costs	Total[1]
Investment in Irrigation Equipment	$2,219,082	$1,360,326	$-	$3,579,409
Total	$2,219,082	$1,360,326	$-	$3,579,409

1 Price base: 2020 dollars, amortized over 24 years at a discount rate of 2.75%

2.1.1. Project Installation Costs

Table D-5 below shows estimated irrigation investment costs by type of irrigation. Because the ideal irrigation system would vary based on conditions at the specific site, we assume investment costs will be on average $2,378/irrigated acre. It is assumed that a well-pivot combination will be utilized. This seems reasonable given the likelihood of farmers using center pivots in the basin area. As stated earlier, we assume an increase in irrigated acres of 4,200 per year for four years.

We assume that 70 percent of program funds will be used for irrigation investment by farmers who qualify for 50 percent cost-share (i.e., federal funds pay 50 percent irrigation investment costs), while 30 percent of program funds will be used for those who qualify for 65 percent cost-share (i.e., federal funds pay 65 percent irrigation investment costs). With these assumptions, the federal expenditures each year are roughly $5.4 million directly on irrigation investment. We assume technical assistance costs are 6.25 percent of federal funds spent on irrigation investment, so approximately $340,000 per year will be paid out in program funds for technical assistance to regulatory agencies. We assume maintenance costs are 2% of the investment cost of the well and 3% of the investment cost of pivots, and operating costs are $35 per acre. This results in average annual NED costs associated with irrigation investment of approximately $3.5 million.

Table D-5. Irrigation Costs Per Acre for Various Systems

Irrigation Type	Estimated Investment Cost Per Acre	Source
Center Pivot	$1,160-$2,400	Morata, Goodrich and Ortiz (2019)
Subsurface Drip	$1,200-$1,800	Amosson et al. (2011), Stubbs (2015)
Surface Drip	$860	Stubbs (2015)
Low-Flow Micro Sprinklers	$2,800	Stubbs (2015)
Side Roll or Wheel Move	$610	Stubbs (2015)

3. Proposed Project Benefits

Table D-6 (NWPM 506.20, Economic Table 5a) summarizes annual average NED project benefits, while D-7 (NWPM 506.21, Economic Table 6) compares them to the annual average project costs presented in Table D-6. Onsite damage reduction benefits that will accrue to agriculture and the local rural community include reduction in crop loss. Offsite benefits include reduced carbon dioxide emissions and nitrogen export to waterways.

Table D-6. Economic Table 5a- Estimated Average Annual Watershed Protection Damage Reduction Benefits, Choc-Pea Basin, Alabama, 2020$

Item	Damage Reduction Benefit, Average Annual	
	Agricultural-Related[1]	Non-Agricultural Related[1]
Onsite Damage Reduction Benefits	$3,947,020	$-
Subtotal	$3,947,020	$-
Offsite Damage Reduction Benefits	$0	
External Carbon Dioxide Reduction		$75,127
External Nitrogen Load Reduction		$180,561
Subtotal	$0	$255,689
Total Quantified Benefits	$3,947,020	$255,689

[1] Price base: 2020 dollars, amortized over 24 years at a discount rate of 2.75%

Table D-7. Economic Table 6- Comparison of Average Annual NED Costs and Benefits, Choc-Pea Basin, Alabama, 2020$

Works of Improvement	Agriculture Related[1]	Non-Agriculture Related[1]	Average Annual Benefits[1]	Average Annual Costs[2]	Benefit Cost Ratio
Investment in Irrigation Equipment	$3,947,020	$255,689	$4,202,709	$3,579,409	1.17
Total	$3,947,020	$255,689	$4,202,709	$3,579,409	1.17

[1]Price base: 2020 dollars, amortized over 24 years at a discount rate of 2.75%

[2]From Economic Table 4

3.1. Benefits Considered and Quantified for Analysis

3.1.1. Onsite Damage Reduction Benefits

Precipitation is critical for rainfed crop development during the growing season, which is historically defined as March through October for corn crops. To gauge the impact of drought on Choc-Pea Basin rainfed corn crops, we analyzed the average precipitation minus the average evapotranspiration.

Assumptions are that when average precipitation is less than average evapotranspiration, plants may become stressed and the year can be considered an agricultural "dry" year due to a precipitation deficit. The opposite can be said when average evapotranspiration is less than average precipitation and can be considered a "wet" year due to adequate precipitation (Figure D-1).

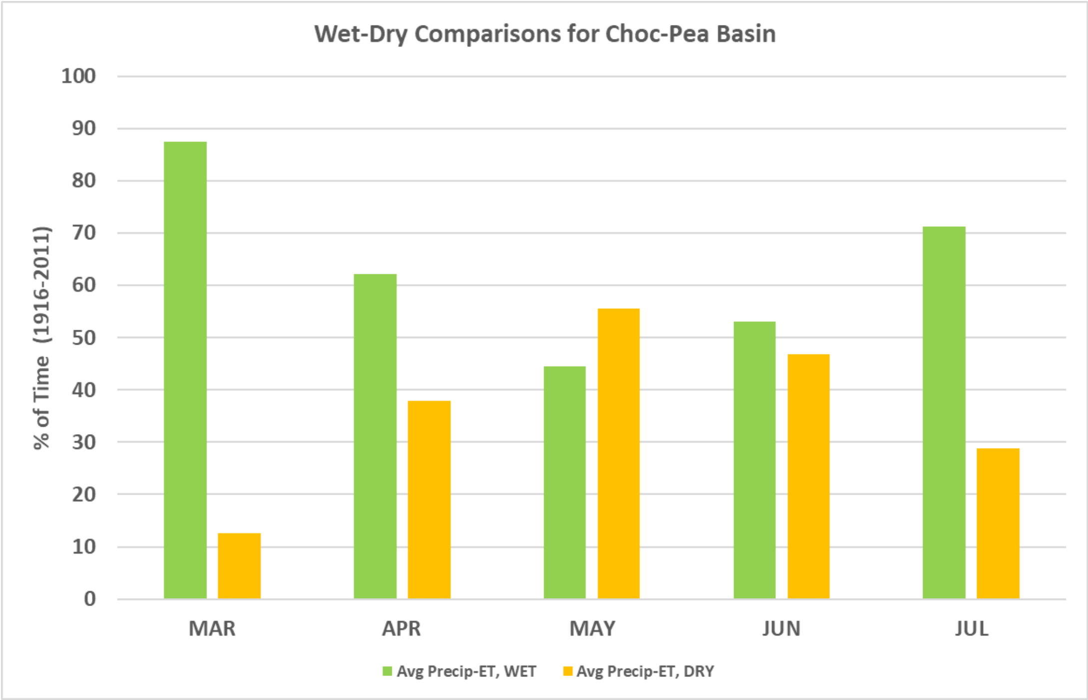

Figure D-1: Percentage of Time that Months During the Growing Season (March – July) Were Wet or Dry from 1916 – 2011

Data indicate a lack of adequate water for crops during the growing season in the Choc-Pea Basin. Average values were weighted across all land surface types and not exclusively cropland evaporation and precipitation, but they are still an indicator of plant stress associated with water consumption.

For example, the month of June is a critical growth period for corn crops, and provides a representation of overall plant health. Similar issues with inadequate precipitation timing in other crops like soybeans and peanuts also exist in the Basin, but corn crops were used in this example. June has a more even ratio of wet and dry years compared to other months (e.g., March), but historical data still show a precipitation deficit more than 45 percent of the time (Figure D-2).

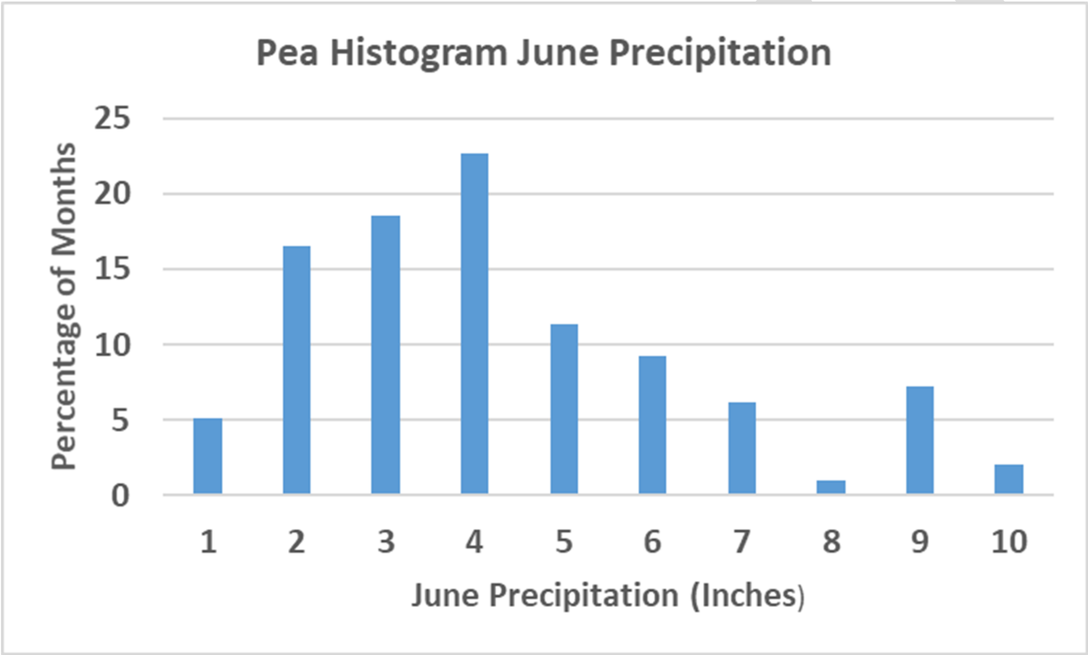

Figure D-2: Precipitation Values for the Month of June in the Pea Basin (1916 – 2011)

In the Choc-Pea Basin, June is considered the beginning of the silking stage for corn, which directly influences kernel weight and number. Corn is very sensitive during the silking stage and can be directly compromised by factors such as drought and extreme heat. During times of drought, silks will grow slowly, fail to emerge in time for pollination, and impact ear development. This further indicates that adequate precipitation is critical for crop development as a period of dryness can directly affect plant health and vigor of corn crops. For example, it has been shown that just one day of moisture stress a week after silking can result in a yield loss of 8 percent (KSU, 2007). Figure D-3 depicts the results from crop models showing yields compared to June precipitation at the agricultural research station in Headland, Alabama.

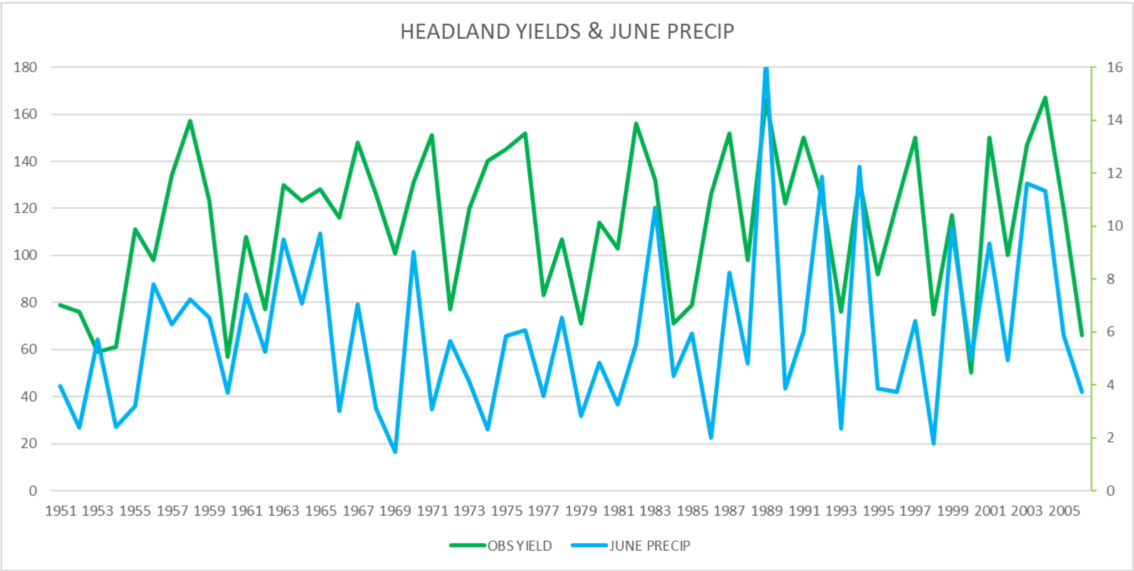

Figure D-3: Historical Corn Yields and June Precipitation for Headland, AL (1951 – 2006)

In the Choc-Pea Basin, a yield of 109 bu/acre for corn is considered sustainable for producers. While the sustainable yield of 109 bu/ac is approximate, it is still a realistic representation of long-term yields in the region. This number was calculated by averaging the "break-even yield – all costs" values with the "break-even yield-variable costs" from 1996 to 2019 using crop data from Headland, Alabama (Figure D-4). Farmers producing yields less than this are considered to be in a production deficit (USDA, n.d.).

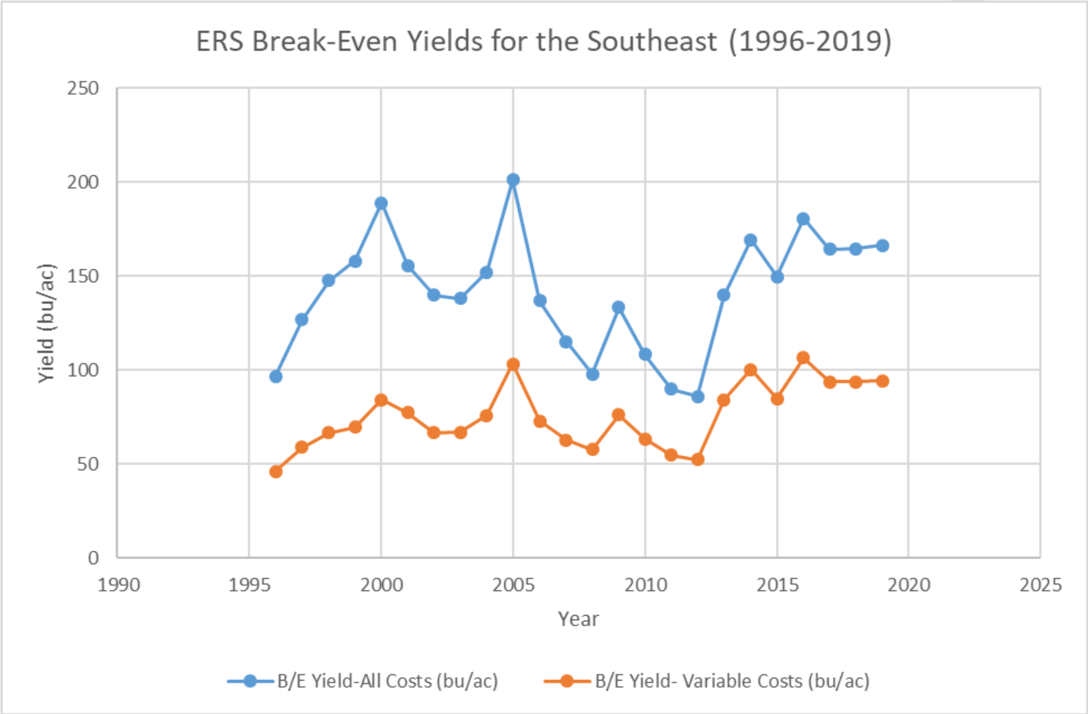

Figure D-4: ERS Historical Break-Even Yield for All Costs and Variable Costs (1951 – 2006)

June precipitation minus evapotranspiration averages were compared to corn crop yields in the Choc-Pea Basin over a period of 54 years (Figure D-5). In 23 of the 54 years (or 41 percent of the time), farmers had yields below 109 bu/acre (production deficit). Of those low yield years, June had a precipitation deficit 39 percent of the time correlating to low yields.

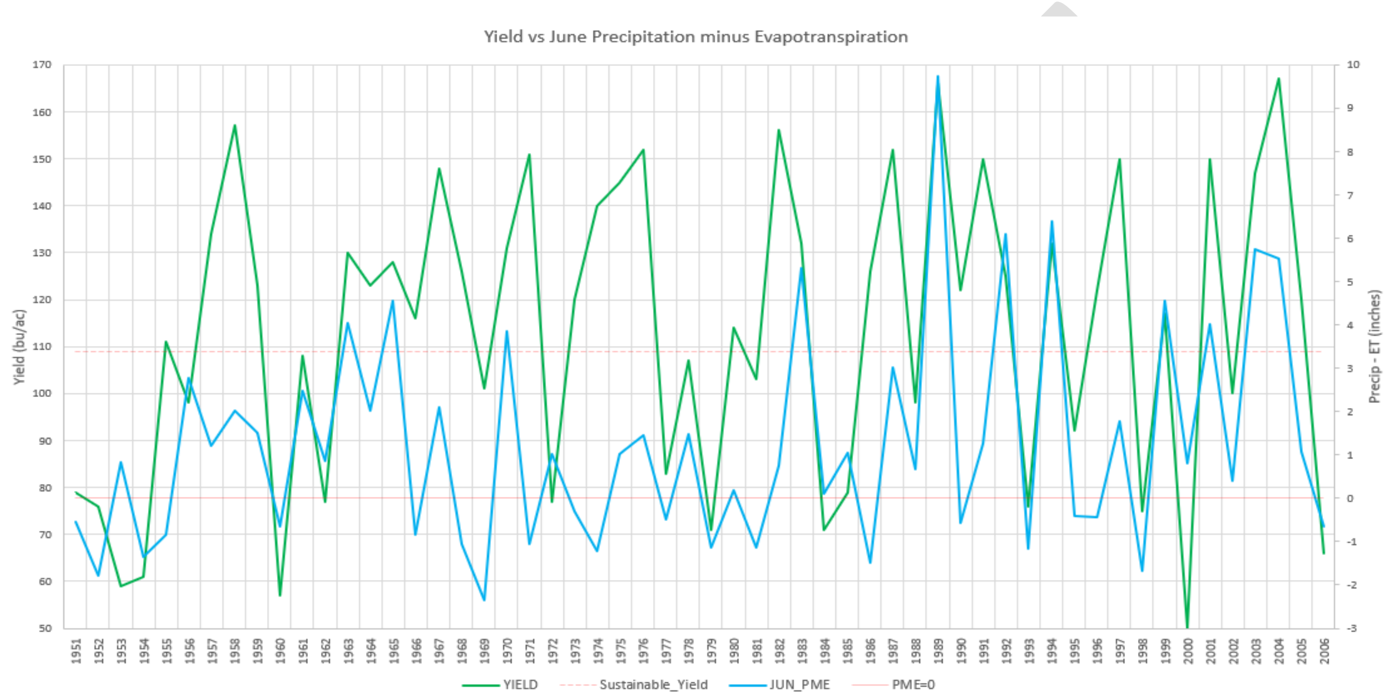

Figure D-5: Historical Corn Yields and June Precipitation Minus Evapotranspiration (PME) for Headland, AL (1951 – 2006)

The differences in net profit per acre between irrigated and non-irrigated crops were estimated using Enterprise Budgets. For corn, soybeans, cotton, and peanuts, we used 2020 Enterprise Budgets provided by the ACES. The net profits per acre and yield goals are displayed in Table D-8 below. Full budgets used for this analysis are included in Appendix D.1 Section 5.1. Irrigation investment costs were removed from each budget because they were accounted for in the cost section of the analysis. The 5-year average Alabama commodity prices in Table D-9 were used to calculate revenues.

Table D-8. Irrigated vs Non-Irrigated Comparison of Net Profits per Acre (Excluding Irrigation Investment Costs)

	Corn (bushels)		Soybeans (bushels)		Cotton (pounds)		Peanuts (pounds)	
	Irrigated	Non-Irr	Irrigated	Non-Irr	Irrigated	Non-Irr	Irrigated	Non-Irr
Yield Goal/Acre	250 bu	120 bu	60 bu	45 bu	1,300 lbs	800 lbs	5,000 lbs	3,000 lbs
Net Profits/Acre	$90.28	$3.18	$55.73	$26.30	$86.91	$119.78	$151.49	$57.96

Table D-9. Average Commodity Prices in Alabama by Year

Year	Corn ($)	Soybean ($)	Cotton ($)	Peanuts ($)
2015	3.74	8.95	0.683	0.178
2016	3.63	9.83	0.710	0.197
2017	4.04	9.43	0.729	0.221
2018	4.11	8.50	0.730	0.208
2019	4.20	9.25	0.640	0.185
5-Year Average	3.94	9.19	0.698	0.198
Source: USDA NASS				

The differences between irrigated and non-irrigated yields (Figure D-6) and profits per acre were used to calculate an average damage reduction benefit per acre. Those differences were weighted by the approximate proportion of total acreage for each basic crop within the basin from the 2019 USDA CropScape Data Layer. As seen in Table D-10, an average damage reduction benefit from irrigation was calculated at $186.45 per irrigated acre.

As stated earlier, an increase of 4,200 irrigated acres/year was assumed for four years. This results in an average annual damage reduction benefit of $4 million associated with irrigation investment, along with a substantial benefit attributed to increases in crop yields, thereby reducing damage to the resources of concern.

Table D-10. Proportional Average Damage Reduction Benefits Per Acre

Crop	Approximate Proportion of Acreage in Basin	Difference Irrigated and Non-irrigated Yields/Acre	Difference Irrigated and Non-irrigated Profits/Acre	Total Damage Reduction in Yields	Weighted Profits/Acre
Corn	12%	130 bu	$87.10	130 bu/acre	$10.61
Soybeans	4%	15 bu	$29.43	15 bu/acre	$1.11
Cotton	47%	500 lbs	$206.69	500 lbs/acre	$97.12
Peanuts	37%	2,000 lbs	$209.45	2,000 lbs/acre	$77.60
Total Average Damage Reduction Benefit/Acre					$186.45

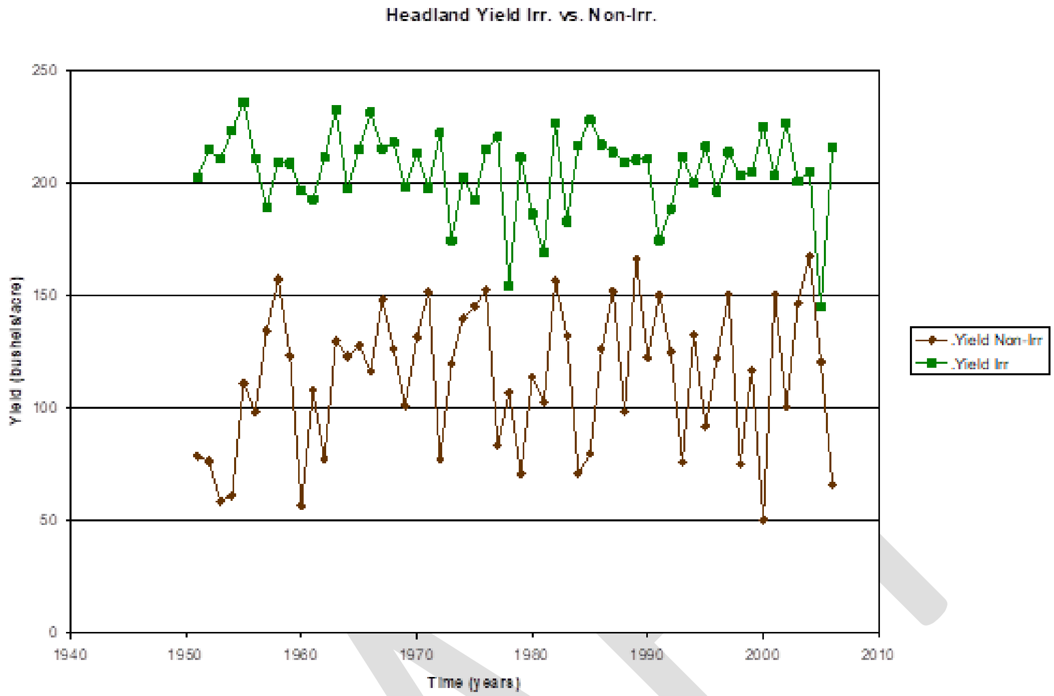

Figure D-6: Historical Irrigated and Non-irrigated Corn Yields for Headland, AL (1951 – 2006)

While not a primary focus of the project, the economic resources required to continue rainfed farming eventually leads to a "break-even" or even loss. This results in an economic drain on the community and region (Figure D-7).

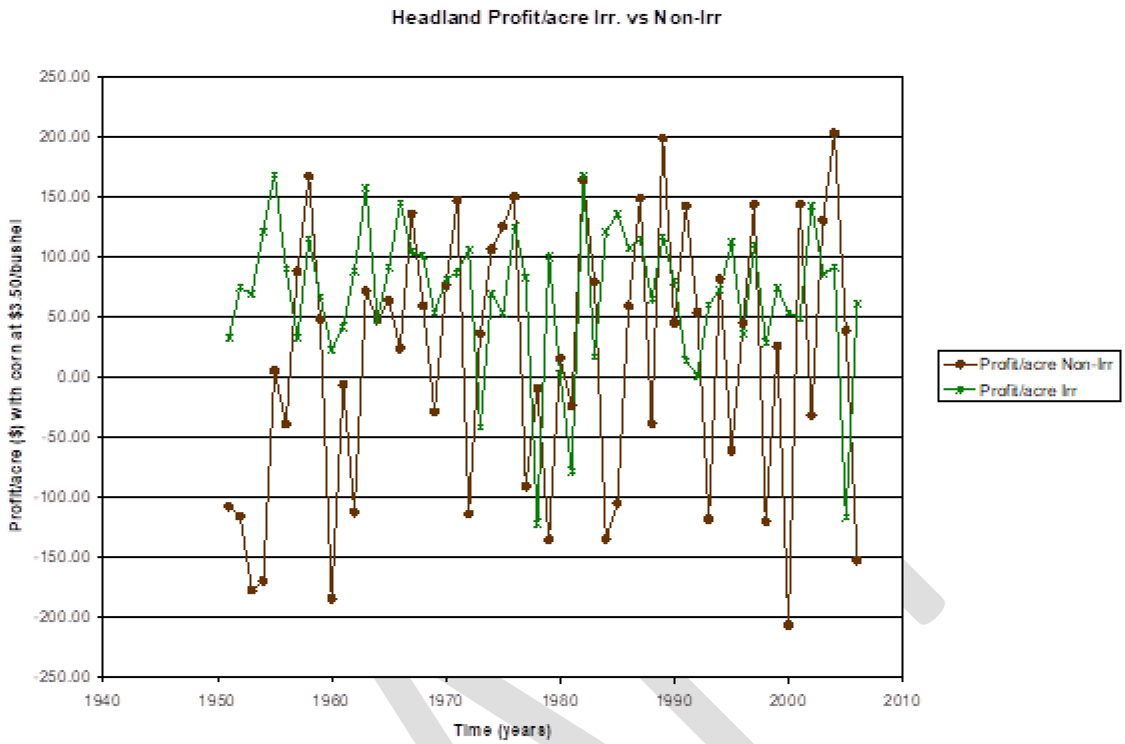

Figure D-7: Historical Profits per Acre for Irrigated and Non-irrigated Corn for Headland, AL (1951 – 2006)

3.1.2. Offsite Damage Reduction Benefits

The value of positive externalities were calculated as offsite benefits of the project and included in the damage reduction benefits. We include reductions in carbon dioxide emissions and nitrogen loss to waterways as offsite benefits.

Carbon dioxide

Net public benefits were determined from increases in in-field soil organic carbon (SOC) that translate to carbon dioxide emission reductions through carbon sequestration. We only consider the effects of SOC increases on carbon dioxide emissions, and do not attempt to quantify the on-site benefits of increased SOC (although they are positive). Unpublished research by Auburn University at the Wiregrass Research and Extension Center in Headland, AL (located just outside of the Choc-Pea Basin, similar soils and climate) noted a significant effect of irrigation coupled with crop rotations on SOC concentration with irrigated plots having relatively 37% more SOC than rainfed plots, 5.41 g kg^{-1} and 3.95 g kg^{-1}, respectively (Shaw et al., 2006) in the top 50 cm. This difference was attributed to the increase in biomass associated with irrigation, and the estimated reduction in carbon emissions amounts to 0.44 metric tons per irrigated acre.

The economic value of carbon dioxide emission reductions was converted into a dollar figure assuming a $12 per metric ton social cost of carbon in 2020, determined assuming a conservative 5% discount rate (Nordhaus, 2017; EPA, 2013). Thus, a conservative estimate of carbon emission reduction is $5.32 per acre annually.

<u>Nitrogen</u>

Based on research from UAH, we assume that 8 kg/ha less nitrogen is exported from irrigated fields than rainfed fields during a dry year and 1.2 kg/ha less during a wet year. We take the average of these values, implicitly assuming one out of every two years is a dry year, obtaining a nitrogen loss reduction of 4.1 lb per acre. A value of $3.13 per lb nitrogen is assumed (Ribaudo et al. 2014), implying an estimate of $12.79 per acre of benefits from nitrogen pollution mitigation

3.1.2.2. Impact of irrigation on nutrient export

Research points toward the benefit of irrigation on a critical non-point source of nutrient pollution in surface and ground water (see Ellenburg, 2011 for a review). Under rainfed condition during a drought, crops do not develop fully and much of the applied fertilizer remains until fall/winter rains wash the residual fertilizer into nearby waterways. When irrigated, crops develop and utilize applied fertilizers and little or no residual fertilizer remains to be a source of pollution. The following graphs (Figure D-8) show the difference between rainfed and irrigated export during a dry year (2010) and a relatively wet year (2011). During a relatively wet year, the nutrient export is almost even for both rainfed and irrigated crops, but the yields are still greater for the irrigated field. It should also be noted that the irrigated treatments include a higher fertilizer application rate and a higher seed planting density rate. Even during the relatively wet growing season, the irrigated fields produce more biomass while making less nitrogen available for export.

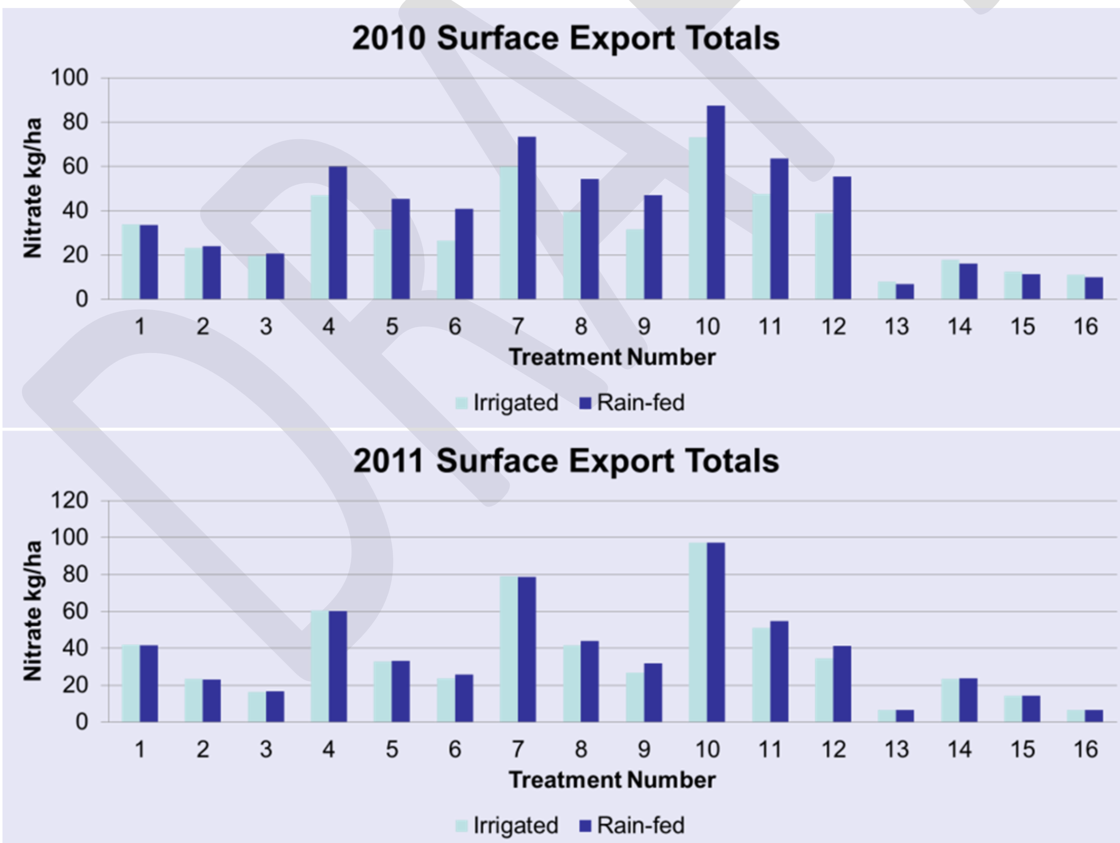

Figure D-8: 2010 and 2011 Nutrient Export Comparison

Using the research to quantify the potential difference between surface nutrient export for irrigated versus rainfed fields equates to about 8 kg/ha difference during relatively dry growing seasons and about 1.2 kg/ha difference during relatively wet growing seasons (Table 11). This is 1.2 kg/ha less nutrient runoff in the irrigated field. So even during adequate rainfall, irrigation allows the nutrients to be watered into the soil and made less available for export to surface water bodies.

Table 11. Surface Nitrogen Export

	Surface N Export (kg/ha)			
	2010		2011	
Trt #	**Irrigated**	**Rainfed**	**Irrigated**	**Rainfed**
1	33.8	33.45	42.01	41.73
2	23.32	23.93	23.55	23.26
3	19.61	20.69	16.44	16.79
4	47.02	59.83	60.51	60.21
5	31.51	45.37	32.79	33.36
6	26.61	40.79	23.61	25.69
7	60.08	73.57	79.04	78.65
8	39.51	54.36	41.68	44.02
9	31.62	47.085	26.83	31.81
10	73.12	87.4	97.07	97.06
11	47.58	63.58	50.92	54.85
12	38.84	55.55	34.42	41.28
13	8.1	6.88	6.72	6.55
14	17.72	16.2	23.53	23.78
15	12.59	11.34	14.48	14.31
16	11.11	9.93	6.74	6.46
Mean	**32.63**	**40.62**	**36.27**	**37.49**

3.1.2.3. Soil resource benefit

Soil health is improved through an increase in soil organic content. Analysis shows that irrigated cropland produces more organic matter that is incorporated back into the soil (Figure D-24 in Appendix D.2 Section 4). This increase in organic content also promotes higher yields and reduces water requirements through improved water-holding conditions in the soil.

4. Regional Economic Development

We calculate Regional Economic Development (RED) benefits following the NRCS Water Resources Handbook for Economics section 611.0504. Agricultural multipliers express the amount of impact increases in agricultural income have on the regional economy. We use an agricultural multiplier from Haggblade, Hammer, and Hazell (1991). We use the multiplier 2.23 which is estimated for the state of Oklahoma and should be similar to Alabama given both are fairly rural. This multiplier is estimated from a Semi-Input-Output model and accounts for effects from interindustry linkages and increases in local income that increases demand for goods and services. We multiply the NED net benefit (average annual equivalent) of $623,301 by the multiplier of 2.23 to get an average annual RED net benefit of $1,389,961.

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5. NED Appendix

5.1. Supplementary Tables

Table D-12. Irrigated Corn Enterprise Budget, 2020$

CORN Irrigated Reduced Tillage- Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.

Following Recommended Management Practices — **Yield Goal** 250 **bushels/acre**

ALABAMA, 2020

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	________
Seed	THOUS.	35.00	3.50	122.50	________
Seed Treatment**	ACRE	1.00	0.00	0.00	________
Tech Fee	ACRE	1.00	0.00	0.00	________
Fertilizer					
Nitrogen*	UNITS	300.00	0.45	135.00	________
Phosphate	UNITS	60.00	0.45	27.00	________
Potash	UNITS	60.00	0.34	20.40	________
Chicken Litter	TONS	0.00	0.00	0.00	________
Micronutrients	ACRE	1.00	5.00	5.00	________
Lime (Prorated)	TONS	0.33	35.00	11.55	________
Herbicides	ACRE	1.00	41.50	41.50	________
Insecticides	ACRE	1.00	8.00	8.00	________
Fungicides	ACRE	1.00	20.00	20.00	________
Nematicide	ACRE	0.50	17.50	8.75	________
Consultant/Scouting Fee	ACRE	0.00	5.00	0.00	________
Irrigation	AC/IN	8.00	12.00	96.00	________
Drying	BU.	250.00	0.25	62.50	________
Hauling	BU.	250.00	0.35	87.50	________
Crop Insurance	ACRE	1.00	20.00	20.00	________
Aerial Application	ACRE	2.00	9.00	18.00	________
Cover Crop Establishment.	ACRE	1.00	20.00	20.00	________
Land Rent	ACRE	1.00	0.00	0.00	________
Labor (Wages & Fringe)	HOUR	2.00	14.23	28.46	________
Tractor/Machinery	ACRE	1.00	28.00	28.00	________
Interest on Operating Capital	DOL.	381.48	0.060	22.89	________
TOTAL VARIABLE COST				**$785.85**	________
(Approximate Range per Acre : $400 to $900)					
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	47.00	47.00	________
Irrigation	ACRE	0.00	125.00	0.00	________
Land Ownership Cost	ACRE	1.00	0.00	0.00	________
General Overhead	DOL.	785.85	0.08	62.87	________
TOTAL FIXED COSTS				**$109.87**	________
(Approximate Range per Acre : $150 to $280)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$895.72**	________

* N rate 1.2 lb. N/Yield Goal Bushel

** Reduced Tillage recommendation of extra insecticide treatment

1 Production costs held constant except for drying and hauling

Table D-13. Non-Irrigated Corn Enterprise Budget, 2020$

CORN Reduced Tillage- Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.

Following Recommended Management Practices — Yield Goal 120 bushels/acre

ALABAMA, 2020

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	________
Seed	THOUS.	25.00	3.50	87.50	________
Seed Treatment**	ACRE	1.00	0.00	0.00	________
Tech Fee	ACRE	1.00	0.00	0.00	________
Fertilizer					
Nitrogen*	UNITS	144.00	0.45	64.80	________
Phosphate	UNITS	40.00	0.45	18.00	________
Potash	UNITS	40.00	0.34	13.60	________
Poultry Litter	TONS	0.00	0.00	0.00	________
Micronutrients	ACRE	1.00	5.00	5.00	________
Lime (Prorated)	TONS	0.33	35.00	11.55	________
Herbicides	ACRE	1.00	41.50	41.50	________
Insecticides	ACRE	0.50	8.00	4.00	________
Fungicides	ACRE	1.00	0.00	0.00	________
Nematicide	ACRE	0.50	17.50	8.75	________
Consultant/Scouting Fee	ACRE	0.00	5.00	0.00	________
Drying	BU.	120.00	0.00	0.00	________
Hauling	BU.	120.00	0.35	42.00	________
Crop Insurance	ACRE	1.00	20.00	20.00	________
Aerial Application	ACRE	0.00	9.00	0.00	________
Cover Crop Establishment.	ACRE	1.00	20.00	20.00	________
Land Rent	ACRE	1.00	0.00	0.00	________
Labor (Wages & Fringe)	HOUR	1.10	14.23	15.65	________
Tractor/Machinery	ACRE	1.00	28.00	28.00	________
Interest on Operating Capital	DOL.	190.18	0.060	11.41	________
TOTAL VARIABLE COST				**$391.76**	________
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	47.00	47.00	________
Irrigation	ACRE	0.00	125.00	0.00	________
Land Ownership Cost	ACRE	1.00	0.00	0.00	________
General Overhead	DOL.	391.76	0.08	31.34	________
TOTAL FIXED COSTS				**$78.34**	________
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$470.10**	________

* N rate 1.2 lb. N/Yield Goal Bushel

** Reduced Tillage recommendation of extra insecticide treatment

1 Production costs held constant except for drying and hauling

Table D-14. Irrigated Cotton Enterprise Budget, 2020$

COTTON IRRIGATED South - Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.
Following Recommended Management Practices — Yield Goal 1300 Pounds per Acre
ALABAMA, 2020 — Cottonseed/Lint Ratio 1.1

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	
Seed & Tech Fee	THOUS.	34.00	2.50	85.00	
Seed Treatment	ACRE	1.00	11.75	11.75	
Fertilizer					
Nitrogen	UNITS	90.00	0.45	40.50	
Phosphate	UNITS	40.00	0.45	18.00	
Potash	UNITS	90.00	0.34	30.60	
Poultry litter	TONS	0.00	0.00	0.00	
Micronutrients/Boron	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	35.00	11.55	
Herbicides					
Burndown/Planting+Post/Lay-By	ACRE	1.00	60.00	60.00	
Insecticides					
Planting, Early, Mid, Late Season	ACRE	1.00	20.00	20.00	
Systemic Fungicides	ACRE	0.00	0.00	0.00	
Growth Regulator	ACRE	1.00	6.00	6.00	
Defol/Harvest Aid	ACRE	1.00	18.00	18.00	
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	
Irrigation	AC/IN	6.00	12.00	72.00	
Crop Insurance	ACRE	1.00	25.00	25.00	
Aerial Application	ACRE	0.00	9.00	0.00	
Boll Weevil Eradication	ACRE	1.00	3.00	3.00	
Cover Crop Establishment.	ACRE	1.00	20.00	20.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	3.50	14.23	49.81	
Tractor/Machinery	ACRE	1.00	67.00	67.00	
Interest on Operating Capital	DOL.	274.10	0.0600	16.45	
Gin/Whse./Loadout/Rec	LB	1300.00	0.12	156.00	
Classing/Promotion Fee	BALE	2.71	3.25	8.80	
Cottonseed Credit	TONS	0.72	115.00	-82.23	
TOTAL VARIABLE COST				**$647.23**	
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	122.00	122.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	647.23	0.08	51.78	
TOTAL FIXED COSTS				**173.78**	
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$821.01**	

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

1 Production costs held constant except Gin/Whse, Classing/Promotion Fee, and Cottonseed Credit

Table D-15. Non-irrigated Cotton Enterprise Budget, 2020$

COTTON South Reduced Tillage - Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.
Following Recommended Management Practices — Yield Goal 800 Pounds per Acre
ALABAMA, 2020 — Cottonseed/Lint Ratio 1.1

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	
Seed & Tech Fee	THOUS.	34.00	2.30	78.20	
Seed Treatment	ACRE	1.00	11.75	11.75	
Fertilizer					
Nitrogen	UNITS	90.00	0.45	40.50	
Phosphate	UNITS	40.00	0.45	18.00	
Potash	UNITS	60.00	0.34	20.40	
Poultry litter	TONS	0.00	0.00	0.00	
Micronutrients/Boron	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	35.00	11.55	
Herbicides					
Burndown/Planting+Post/Lay-By	ACRE	1.00	60.00	60.00	
Insecticides					
Planting, Early, Mid, Late Season	ACRE	1.00	20.00	20.00	
Systemic Fungicides	ACRE	0.00	0.00	0.00	
Growth Regulator	ACRE	1.00	4.00	4.00	
Defol/Harvest Aid	ACRE	1.00	16.00	16.00	
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	
Irrigation	AC/IN	0.00	12.00	0.00	
Crop Insurance	ACRE	1.00	25.00	25.00	
Aerial Application	ACRE	0.00	9.00	0.00	
Boll Weevil Eradication	ACRE	1.00	3.00	3.00	
Cover Crop Establishment.	ACRE	1.00	20.00	20.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	3.20	14.23	45.54	
Tractor/Machinery	ACRE	1.00	67.00	67.00	
Interest on Operating Capital	DOL.	225.47	0.0600	13.53	
Gin/Whse./Loadout/Rec	LB	800.00	0.12	96.00	
Classing/Promotion Fee	BALE	1.67	3.25	5.42	
Cottonseed Credit	TONS	0.44	115.00	-50.60	
TOTAL VARIABLE COST				$515.28	
(Approximate Range per Acre : $325 to $750)					
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	122.00	122.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	515.28	0.08	41.22	
TOTAL FIXED COSTS				163.22	
(Approximate Range per Acre : $90 to $300)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				$678.50	
(Approximate Range per Acre : $400 to $1050)					

1 Production costs held constant except Gin/Whse, Classing/Promotion Fee, and Cottonseed Credit

Table D-16. Irrigated Soybeans Enterprise Budget, 2020$

SOYBEANS IRRIGATED- Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.
Following Recommended Management Practices — Yield Goal 60 Bushels per acre
ALABAMA, 2020

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	1.00	1.00	________
Seed & Inoculant	BAG	1.00	55.00	55.00	________
Fertilizer					
Nitrogen	UNITS	30.00	0.45	13.50	________
Phosphate	UNITS	60.00	0.45	27.00	________
Potash	UNITS	60.00	0.34	20.40	________
Poultry Litter	TONS	0.00	0.00	0.00	________
Boron /Micronutrients	ACRE	1.00	10.00	10.00	________
Lime (Prorated)	TONS	0.33	40.00	13.20	________
Herbicides	ACRE	1.00	45.00	45.00	________
Insecticides	ACRE	1.00	8.00	8.00	________
Fungicides	ACRE	1.00	14.00	14.00	________
Nematicide	ACRE	1.00	0.00	0.00	________
Consultant/Scouting Fee	ACRE	0.00	6.00	0.00	________
Irrigation	AC/IN	6.00	12.00	72.00	________
Drying	BU.	60.00	0.00	0.00	________
Hauling	BU.	60.00	0.80	48.00	________
Crop Insurance	ACRE	1.00	20.00	20.00	________
Aerial Application	ACRE	0.00	9.00	0.00	________
Cover Crop Establishment.	ACRE	1.00	20.00	20.00	________
Labor (Wages & Fringe)	HOUR	1.05	14.23	14.94	________
Tractor/Machinery	ACRE	1.00	26.00	26.00	________
Interest on Operating Capital	DOL.	203.52	0.0600	12.21	________
TOTAL VARIABLE COST				**$419.25**	________
(Approximate Range per Acre : $125 to $400)					
2. FIXED COSTS					
TRACTOR/MACHINERY	ACRE	1.00	43.00	43.00	________
IRRIGATION	ACRE	0.00	125.00	0.00	________
LAND OWNERSHIP COST	ACRE	1.00	0.00	0.00	________
GENERAL OVERHEAD	DOL.	419.25	0.08	33.54	________
TOTAL FIXED COSTS				**$76.54**	________
(Approximate Range per Acre : $50 to $275)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$495.79**	________
(Approximate Range per Acre : $175 to $600)					

1 Production costs held constant except fordrying and hauling

Table D-17. Non-Irrigated Soybean Enterprise Budget, 2020$

SOYBEANS - Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.
Following Recommended Management Practices — Yield Goal 45 Bushels per acre
ALABAMA, 2020

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	1.00	1.00	
Seed & Inoculant	BAG	1.00	55.00	55.00	
Fertilizer					
Nitrogen	UNITS	0.00	0.45	0.00	
Phosphate	UNITS	60.00	0.45	27.00	
Potash	UNITS	60.00	0.34	20.40	
Poultry Litter	TONS	0.00	0.00	0.00	
Boron /Micronutrients	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	40.00	13.20	
Herbicides	ACRE	1.00	45.00	45.00	
Insecticides	ACRE	1.00	8.00	8.00	
Fungicides	ACRE	1.00	14.00	14.00	
Nematicide	ACRE	1.00	0.00	0.00	
Consultant/Scouting Fee	ACRE	0.00	6.00	0.00	
Irrigation	AC/IN	0.00	12.00	0.00	
Drying	BU.	45.00	0.00	0.00	
Hauling	BU.	45.00	0.80	36.00	
Crop Insurance	ACRE	1.00	20.00	20.00	
Aerial Application	ACRE	0.00	9.00	0.00	
Cover Crop Establishment.	ACRE	1.00	20.00	20.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	1.05	14.23	14.94	
Tractor/Machinery	ACRE	1.00	26.00	26.00	
Interest on Operating Capital	DOL.	154.77	0.0600	9.29	
TOTAL VARIABLE COST				**$318.83**	
(Approximate Range per Acre : $125 to $400)					
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	43.00	43.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	318.83	0.08	25.51	
TOTAL FIXED COSTS				**$68.51**	
(Approximate Range per Acre : $50 to $275)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$387.33**	
(Approximate Range per Acre : $175 to $600)					

1 Production costs held constant except for drying and hauling

Table D-18. Irrigated Peanut Enterprise Budget, 2020$

PEANUT - IRRIGATED Enterprise Planning Budget Summary

Estimated Costs Per Acre
Following Recommended Management Practices
ALABAMA, 2020

Note: To customize this budget, you may change any numbers in blue.

Yield Goal 2.50 Tons per Acre*
5,000 *Pounds per Acre

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm. The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	
Seed	LBS.	125.00	0.85	106.25	
Innoculant	ACRE	1.00	0.00	0.00	
Fertilizer					
Nitrogen	UNITS	0.00	0.00	0.00	
Phosphate	UNITS	0.00	0.45	0.00	
Potash	UNITS	0.00	0.34	0.00	
Poultry Litter	TONS	0.00	0.00	0.00	
Boron /Micronutrients	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	35.00	11.55	
Gypsum	TONS	0.33	75.00	24.75	
Herbicides	ACRE	1.00	75.00	75.00	
Insecticides- In Furrow	ACRE	1.00	15.00	15.00	
Insecticides- Foliar	ACRE	1.00	12.00	12.00	
Fungicides	ACRE	6.00	12.00	72.00	
Nematicide	ACRE	0.00	30.00	0.00	
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	
Irrigation	AC/IN	8.00	12.00	96.00	
Drying	TONS	2.50	15.00	37.50	
Cleaning	TONS	2.50	10.00	25.00	
Hauling	TONS	2.50	10.00	25.00	
Crop Insurance	ACRE	1.00	30.00	30.00	
Check Off	TON	2.50	2.50	6.25	
Cover Crop Establishment	ACRE	1.00	20.00	20.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	3.50	14.23	49.81	
Tractor/Machinery	ACRE	1.00	59.00	59.00	
Interest on Operating Capital	DOL.	337.55	0.0600	20.25	
TOTAL VARIABLE COST				$695.36	
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	90.00	90.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	695.36	0.075	52.15	
TOTAL FIXED COSTS				142.15	
3. TOTAL COST OF ALL SPECIFIED EXPENSES				$837.51	

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

1 Production costs held constant except for drying & cleaning, hauling, and checkoff.

* PRODUCTION COSTS ARE CONSTANT FOR THIS TABLE

Table D-19. Non-irrigated Peanut Enterprise Budget, 2020$

PEANUT - Enterprise Planning Budget Summary

Estimated Costs Per Acre — **Note: To customize this budget, you may change any numbers in blue.**

Following Recommended Management Practices — **Yield Goal** — **1.5 Tons per Acre***

ALABAMA, 2020 — 3,000 *Pounds per Acre

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.

The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	
Seed	LBS.	125.00	0.85	106.25	
Innoculant	ACRE	1.00	0.00	0.00	
Fertilizer					
Phosphate	UNITS	0.00	0.45	0.00	
Potash	UNITS	0.00	0.32	0.00	
Poultry Litter	TONS	0.00	0.00	0.00	
Boron /Micronutrients	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	40.00	13.20	
Gypsum	TONS	0.33	75.00	24.75	
Herbicides	ACRE	1.00	75.00	75.00	
Insecticides- In Furrow	ACRE	1.00	15.00	15.00	
Insecticides- Foliar	ACRE	1.00	10.00	10.00	
Fungicides	ACRE	5.00	12.00	60.00	
Nematicide	ACRE	0.00	30.00	0.00	
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	
Irrigation	AC/IN	0.00	12.00	0.00	
Drying	TONS	1.50	15.00	22.50	
Cleaning	TONS	1.50	10.00	15.00	
Hauling	TONS	1.50	10.00	15.00	
Crop Insurance	ACRE	1.00	30.00	30.00	
Check Off	TON	1.50	2.50	3.75	
Cover Crop Establishment	ACRE	1.00	20.00	20.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	3.20	14.23	45.54	
Tractor/Machinery	ACRE	1.00	59.00	41.00	
Interest on Operating Capital	DOL.	253.49	0.0600	15.21	
TOTAL VARIABLE COST				**$522.20**	
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	90.00	90.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	522.20	0.075	39.16	
TOTAL FIXED COSTS				129.16	
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$651.36**	

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

1 Production costs held constant except for drying & cleaning, hauling, and checkoff.

D.2 Natural Resources Models and Results

Natural Resource Investigation and Analysis

1. Data Layers and GIS Model

Working with the NWMC to distinguish an ideal/feasible watershed for the development of the PL-566 project, a recommended outline of data layers was identified. Sources for these data layers were then identified and acquired during the completion of a Statewide Resource Assessment. Table D-20 presents the list of these SRA data layers and identified sources. In some cases, data sources were modified and updated over the course of the project. As information was presented to the steering committee, source organizations provided updated or preferred data.

Table D-20. List of SRA Data Layers and Identified Sources

Chapter	Data Layer	Sources
1	Soils	*Soil Survey Staff. The Gridded Soil Survey Geographic (gSSURGO) Database for Alabama. United States Department of Agriculture, Natural Resources Conservation Service. Available online at* https://gdg.sc.egov.usda.gov/ *FY2015 official release.*
2	ADEM/Water Quality	Alabama's 2018 303(d) List provided directly by Chris Johnson, Water Quality Branch Chief. Also using SPARROW model as a baseline fertilizer loading for each HUC8 (https://water.usgs.gov/nawqa/sparrow/sparrow-mod.html).
3	Cropping Information by Field	Alabama Irrigation Initiative data. USDA National Agricultural Statistics Service Cropland Data Layer. 2017 Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/. USDA-NASS, Washington, DC.
4	Land Use	USDA National Agricultural Statistics Service Cropland Data Layer. 2017 Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/. USDA-NASS Washington, DC.
5	Survey Results	https://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Alabama/.
6	Climate/Weather	Alabama State Climate Office.
7	Surface Water	2017 OWR Surface Water Assessment (http://adeca.alabama.gov/Divisions/owr/watermanagement/Pages/Reports-and-information.aspx).
8	Ground Water	2017 OWR Surface Water Assessment (http://adeca.alabama.gov/Divisions/owr/watermanagement/Pages/Reports-and-information.aspx). Also well monitoring reports from the GSA .
9	Environmental Justice Layer	US Census Data (http://www.alabamaview.org/GISTigerfiles.php).
10	Cultural Resources	Alabama Register of Landmarks & Heritage (http://www.arcgis.com/home/webmap/viewer.html?extent=-92.1118%2C29.7817%2C-

Table D-20. List of SRA Data Layers and Identified Sources

Chapter	Data Layer	Sources
		81.2628%2C35.4411&webmap=f516bf2b1a94408aa14eb25b54787442).
11	T&E Species	US Fish & Wildlife: Alabama Strategic Habitat Unit mapping data and Alabama T&E Species Table. Provided directly from Jeff Powell, Deputy Field Supervisor, AL Ecological Services Field Office.
	Flood Maps for Watershed Areas	Federal Emergency Management Agency (https://msc.fema.gov/).
	Digital Elevation Model	Slope is captured in the land capability class in SSURGO.
12	Stakeholder Engagement	Covered initially in the Survey results and more meetings to follow after the SRA is complete.
13	Ranking Tool	Kao, Chiang. "Weight determination for consistently ranking alternatives in multiple criteria decision analysis." *Applied Mathematical Modelling* 34, no. 7 (2010): 1779-1787. Chuang Y. -C., C. -T. Chen, and C. Hwang, 2016: A simple and efficient real-coded genetic algorithm for constrained optimization. *Applied Soft Computing, 38, 87-105.*

2. Water Quality

2.1. Existing ADEM Watershed Management Plans

Water management plans previously established in the project area by ADEM funded projects have been evaluated and reviewed as part of the water quality assessment as it relates to the intended actions of this project. The Hurricane Creek-Dowling Branch Sub Watershed Plan created by ADEM in 2008 provides information and recommendation regarding Dowling Branch in the Hurricane Creek Watershed within the larger Upper Choctawhatchee Watershed. Another watershed management plan already existing in the project area is the Choctawhatchee, Pea, and Yellow Rivers Watershed Management Plan (CPYRWMP) which provides information and recommendations about protection of resources within the Choctawhatchee, Pea, and Yellow River watersheds. Both plans provided information that was used in addressing potential concerns that may affect impaired waters, TMDLs, or nonpoint source pollution.

The intentions of this program are to support existing farmland and provide environmental benefits through sustainable irrigation expansion. Though some streams have pollution levels of concern that are identified in this Plan, the USDA-NRCS will adhere to ADEM's NPS guidelines outlined in the above plans. Furthermore, in addition to requiring NRCS onsite EEs (Form CPA-52), this EA focuses on reducing damages to resources of concern by promoting sustainable levels of irrigation density and water use, while favoring voluntary farmer stewardship and current use of BMPs, and also requiring updated comprehensive nutrient management plans.

2.2. SPARROW Modeling

The Spatially Referenced Regression on Watershed attributes (SPARROW) models used in this EA were developed by the United States Geological Survey (USGS) to aid responsible authorities to model long-term water quality. The model set consists of flow, nitrogen, phosphorus, and sediment components. Models have been developed at the national, regional, and local spatial scales, and are widely employed by national, state, and local authorities to model the impacts of land use activities on resultant water quality for planning and TMDL purposes.

SPARROW models are statistical regression models that are hybrid in nature as physical watershed processes are considered. Independent variables that are related to the particular dependent water quality variable under consideration are regressed using all available water quality data. For example, the nitrogen model consists of independent variables including atmospheric deposition, fertilizer, and manure applications. Variables can be either sources of nitrogen (such as those previously listed) or transport related such as decay coefficients and stream velocities. The resulting SPARROW model is a multi-variable regression equation. A watershed is discretized into stream reaches and contributing areas (average area approximately 4,000 km^2), and the regression equation is used to predict the requisite dependent variable for each stream reach.

The SPARROW model was also used to evaluate the effect of increased irrigation on agricultural lands and the associated changes in fertilizer loads to estimate future TN loads for reaches in the Choc-Pea Basin. Two modeling scenarios were simulated based on the following assumptions: (1) 10 percent of the total land area in each HUC will be irrigated to enhance agriculture; (2) Or, all existing agricultural land in the Choc-Pea will be irrigated to enhance agriculture. The SPARROW model results for each of the scenarios described above do result in increases of TN loads in the hydrologic system. However, the 10 percent of total land area scenario does not result in any additional reaches exceeding the recommended EPA benchmark (EPA, 2013). It is important to note that the EPA recommendations are used as a benchmark suggestion and are not regulations set by the state of Alabama. In scenario (1), all of the reaches that are above the recommended benchmark had baseline data that already exceeded that of the recommendation. In the irrigation of all existing agricultural land scenario, there are also branches that increase their TN loads significantly. However, the reaches that increase the most are the ones that already had baseline data above the benchmark. The Hurricane Creek and Barnes Creek reaches are estimated to approximately double their TN loads from 11 to 21 mg/L in the second scenario. In scenario (2), there is one additional reach that now exceeds the recommendation, which is the Lower Choctawhatchee River at 7.71 mg/L. The TN data for all of the reaches in the Choc-Pea Basin can be found in Table D-21.

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
HURRICANE CR	141.16	24.16	10.89	13.11	21.46
BARNES CR	41.09	10.00	10.74	12.45	21.36
NEWTON CR	100.09	21.24	9.80	11.19	14.84
LITTLE CHOCTAWHATCHEE R	37.26	39.99	9.20	10.37	13.58
BEAR CR	65.54	21.04	7.35	8.56	14.34
PATES CR	49.40	13.33	6.44	7.58	12.37
LITTLE CHOCTAWHATCHEE R	138.90	80.81	6.29	7.23	10.75
LITTLE CHOCTAWHATCHEE R	67.91	13.75	4.46	5.50	7.71

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
HURRICANE CR	72.74	15.20	4.32	5.30	5.60
SKIES CR	94.07	24.79	3.87	4.59	5.96
BELL CR	45.75	14.79	3.70	4.37	6.97
WILKESON CR	21.16	35.20	3.13	3.71	5.99
BLACKWOOD CR	116.47	42.21	3.11	3.69	6.33
WALNUT CR	119.99	57.41	2.95	3.46	3.96
HARRAND CR	52.69	18.33	2.89	3.46	3.87
SPRING CR	131.40	109.41	2.75	3.30	5.43
CHOCTAWHATCHEE R, E FK	164.93	69.07	2.44	2.92	3.84
JUDY CR	133.20	24.58	2.38	3.41	3.90
BEAR CR	91.16	22.70	2.33	3.11	3.63
WILKESON CR	27.51	15.41	2.26	2.62	4.31
STEEP HEAD CR	33.48	9.37	2.23	3.01	4.01
CHOCTAWHATCHEE R	118.49	1,060.24	1.84	2.28	3.32
DOUBLE BRIDGES CR	81.95	268.81	1.83	2.01	2.47
BIG CR	79.58	37.22	1.81	2.26	2.71
CHOCTAWHATCHEE R	6.45	821.12	1.78	2.21	3.17
WHITEWATER CR	6.52	119.65	1.77	2.17	2.63
MIMS CR	45.92	26.05	1.76	2.17	3.00
BEAR CR	92.97	22.29	1.73	2.54	3.12
PEA CR	144.90	107.05	1.67	2.13	2.49

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
CHOCTAWHATCHEE R	8.46	1,016.49	1.63	2.02	2.89
CLAYBANK CR	93.96	22.29	1.62	2.44	2.92
JUDY CR	86.01	67.07	1.59	2.31	2.63
SILERS CR	104.12	60.79	1.59	2.27	2.97
LITTLE JUDY CR	78.00	28.95	1.58	2.08	2.53
CHOCTAWHATCHEE R	1.14	1,665.76	1.58	1.92	2.76
CHOCTAWHATCHEE R	17.52	976.50	1.57	1.96	2.78
CHOCTAWHATCHEE R	9.75	795.71	1.52	1.89	2.64
CHOCTAWHATCHEE R	30.07	776.76	1.51	1.89	2.61
CHOCTAWHATCHEE R, W FK	86.62	51.02	1.51	1.88	2.26
PEA CR	74.80	37.22	1.47	1.89	2.19
CHOCTAWHATCHEE R, W FK	27.30	187.17	1.44	1.77	2.20
CHOCTAWHATCHEE R, E FK	125.34	138.56	1.42	1.86	2.30
DOUBLE BRIDGES CR	23.81	434.81	1.41	1.59	2.11
SILERS CR	85.16	128.82	1.41	2.02	2.59
CLAYBANK CR	146.74	147.04	1.41	1.82	2.36
WHITEWATER CR	183.30	224.83	1.39	1.91	2.24
CLEARWATER CR	57.88	41.97	1.37	1.72	2.65
SANDY CR	68.40	103.97	1.37	1.69	2.69
LINDSEY CR	104.65	72.58	1.36	1.66	2.05

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
CHOCTAWHATCHEE R, E FK	89.46	330.29	1.36	1.74	2.54
CHOCTAWHATCHEE R, W FK	54.87	153.22	1.29	1.57	1.95
BLUFF CR	29.02	29.43	1.25	1.60	2.47
FLAT CR	132.58	129.57	1.25	1.66	2.40
BOWLES CR	76.28	18.54	1.23	1.98	1.98
RICHLAND CR	131.37	52.57	1.22	1.72	2.30
HOLLY MILL CR	59.46	55.84	1.20	1.43	2.27
CHOCTAWHATCHEE R	21.86	650.75	1.18	1.55	2.08
CHOCTAWHATCHEE R, W FK	93.86	232.99	1.18	1.52	1.83
BIG CR	11.53	414.92	1.16	1.63	1.96
DOUBLE BRIDGES CR	57.65	599.87	1.14	1.32	1.81
CHOCTAWHATCHEE R, W FK	68.51	314.01	1.12	1.51	1.81
CHOCTAWHATCHEE R	39.71	4,630.60	1.10	1.41	1.98
CHOCTAWHATCHEE R, E FK	55.07	184.60	1.10	1.48	1.80
STEEP HEAD CR	56.86	39.99	1.07	1.61	1.77
SILERS CR	17.04	179.96	1.06	1.53	1.91
DOUBLE BRIDGES CR	102.60	110.35	1.06	1.27	1.76
CHOCTAWHATCHEE R, E FK	139.23	275.41	1.00	1.34	1.77

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
BIG CR	9.22	477.64	0.98	1.38	1.65
HAYS CR	44.75	42.87	0.98	1.21	1.83
TIGHT EYE CR	111.23	130.16	0.95	1.15	1.80
PAGES CR	32.41	38.36	0.95	1.14	1.82
WHITEWATER CR	85.52	54.04	0.92	1.26	1.78
TENMILE CR	126.34	147.61	0.91	1.31	1.94
LITTLE DOUBLE BRIDGES CR	62.21	72.63	0.90	1.10	1.69
BUCKHORN CR	121.76	56.02	0.89	1.33	1.67
BUCKS MILL CR	80.67	54.71	0.88	1.20	1.57
WRIGHTS CR	104.49	497.66	0.87	1.21	1.81
PINEY WOODS CR	51.73	33.68	0.86	1.20	1.37
STINKING CR	51.58	29.55	0.86	1.23	1.23
CHOCTAWHATCHEE R	58.22	7,270.79	0.85	1.13	1.57
CLAYBANK CR	50.95	57.28	0.82	1.22	1.44
CHOCTAWHATCHEE R	51.84	7,529.26	0.82	1.09	1.51
PEA R	109.42	1,781.99	0.81	1.09	1.43
CLAYBANK CR	9.93	102.68	0.80	1.19	1.36
BEAVERDAM CR	67.10	83.94	0.78	0.97	1.50
PEA R	48.05	2,780.93	0.77	1.06	1.41
PEA R	113.13	1,593.31	0.77	1.06	1.34
PEA R	252.46	2,576.01	0.76	1.05	1.38

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
PEA R	0.36	488.08	0.75	1.04	1.23
PEA R	87.32	572.87	0.73	1.01	1.23
BOWDEN MILL CR	49.07	33.38	0.72	1.04	1.36
PEA R	150.90	53.34	0.72	1.30	1.66
PEA R	1.58	1,495.16	0.72	1.00	1.23
PEA R	32.98	1,447.78	0.71	1.00	1.22
PEA R	3.71	1,284.65	0.70	0.99	1.19
PEA R	63.63	1,372.76	0.69	0.98	1.18
PEA R	30.93	382.56	0.69	0.99	1.14
PEA R	59.48	633.80	0.68	0.95	1.17
PEA R	10.40	449.32	0.67	0.96	1.13
FLAT CR	18.72	310.94	0.65	0.88	1.23
POOR CR	52.84	41.35	0.64	0.92	1.23
EIGHTMILE CR	302.38	239.94	0.64	0.93	1.23
PEA R	152.89	732.70	0.64	0.89	1.11
PEA CR	58.64	33.77	0.63	0.93	0.93
BEAVER DAM	80.57	53.07	0.59	0.91	1.00
FLAT CR	16.24	598.87	0.59	0.82	1.12
PEA R	95.43	803.63	0.54	0.75	0.93
PEA R	2.25	87.10	0.48	0.89	1.10
PANTHER CR	84.26	104.59	0.39	0.60	0.71

Table D-21. Nitrogen Concentrations of Choctawhatchee and Pea River Basin Reaches from the SPARROW Model

*Reach Name	Basin (km^2)	Mean Flow (cfs)	Baseline (mg/L)	10% of HUC (mg/L)	All Ag. Land (mg/L)
PEA R	4.38	143.51	0.38	0.71	0.88
PEA R	79.11	197.23	0.38	0.67	0.78
PEA R	54.14	258.62	0.36	0.62	0.70
PEROTE CR	65.67	32.62	0.34	0.59	0.59
PEA CR	63.14	47.76	0.33	0.51	0.51
LITTLE INDIAN CR	67.46	47.96	0.32	0.61	0.78
PANTHER CR	26.00	26.86	0.26	0.42	0.42
BIG SANDY CR	46.96	35.68	0.24	0.46	0.46
SPRING CR ALT	29.42	28.39	0.21	0.44	0.45
RED OAK CR	14.04	22.68	0.16	0.23	0.23

The southeast portion of the Choc-Pea contains the reaches with the highest existing TN concentrations in the East and West Forks of the Choctawhatchee River including portions of Dale and Geneva counties (Figure D-9). These higher concentrations may be attributed to the urbanizing areas found within this portion of the Choc-Pea. While a few other HUC-12 regions show streams with TN concentrations between the EPA recommended guidelines (EPA, 2013), most of the Choc-Pea Basin has a TN concentration less than 2 mg/L. For the 10 percent of HUC land area irrigation simulation, more reaches and associated sub watersheds along the Pea River, Pea Creek and the northern segment of the West Choctawhatchee River move into the EPA recommended guidelines for TN (Figure D-10). The simulation that assumed all existing agricultural land would be irrigated has the most effect of TN concentrations. Additional reaches and tributaries of the Choctawhatchee and Pea Rivers exceed 6 mg/L TN and additional reaches in the northeast and northwest areas of the Choc-Pea Watershed move into the EPA recommended guidelines (Figure D-11).

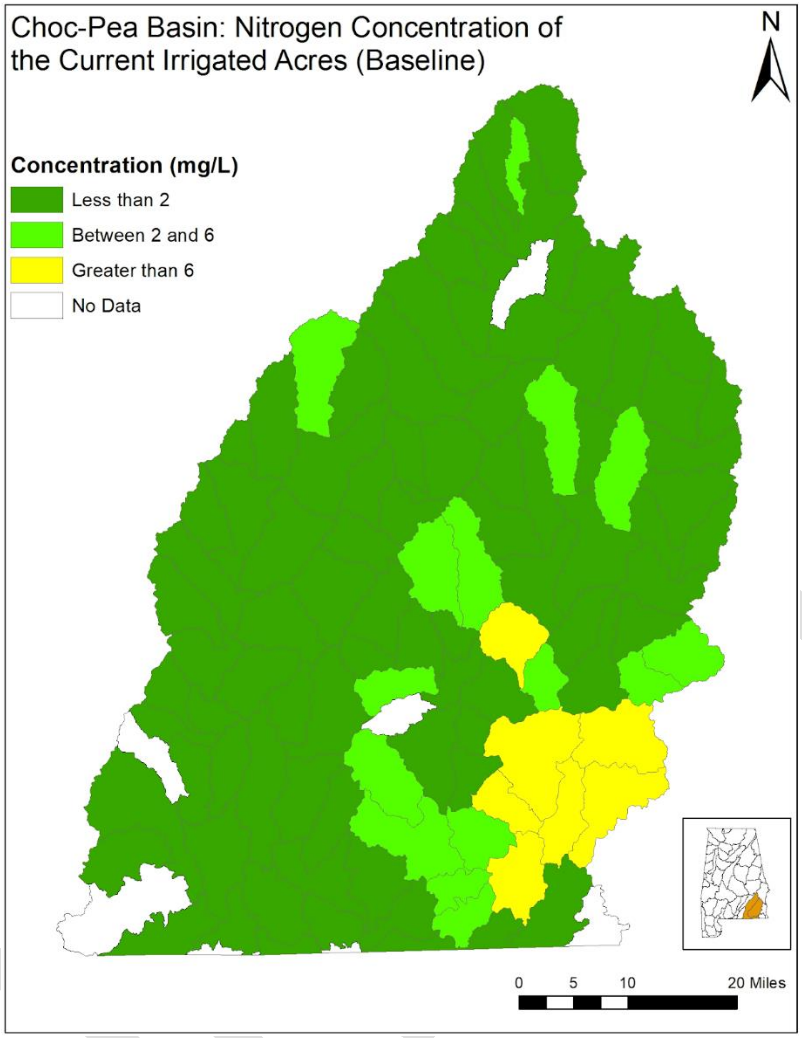

Figure D-9: Baseline or Existing TN Concentrations for Reaches Aggregated to the HUC-12 Level

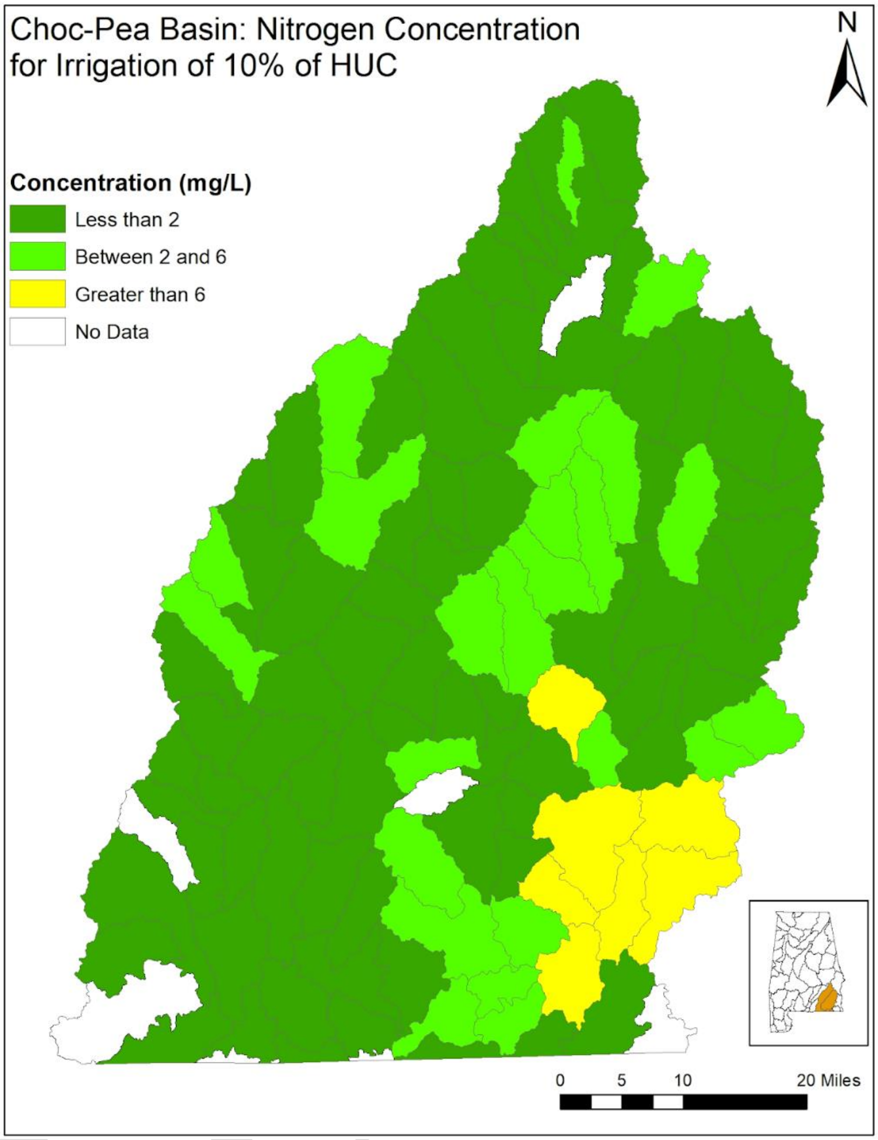

Figure D-10: TN Concentrations for the 10 Percent of HUC Scenario Aggregated for Reaches to the HUC-12 Level

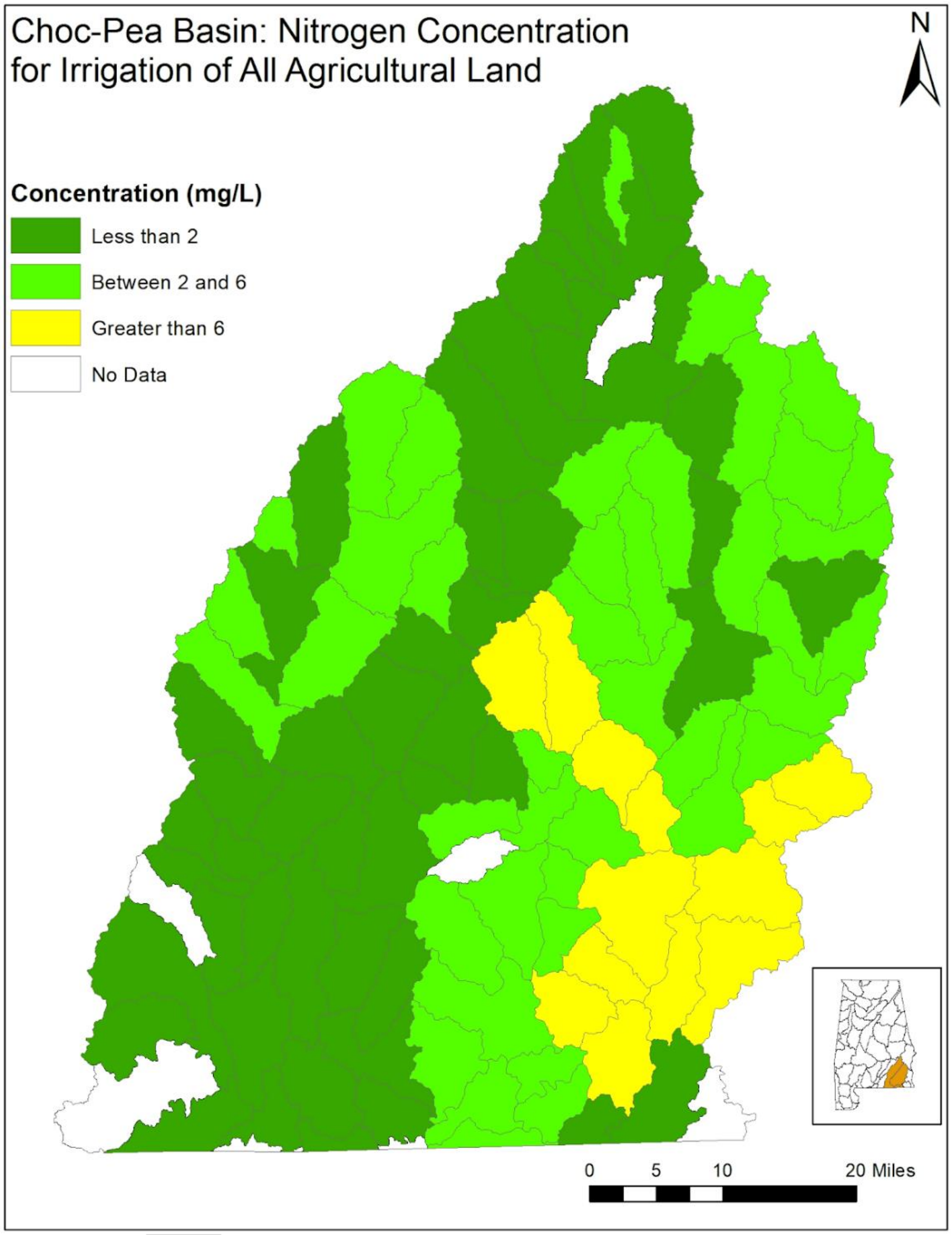

Figure D-11: TN Concentrations for all Agricultural Land Scenario Aggregated for Reaches to the HUC-12 Level

3. Water Quantity

According to the USGS and OWR assessment, irrigation withdrawals in the basin are from both surface water and groundwater sources. The exact breakdown of surface and groundwater use varies for each of the HUC-8 Watersheds as follows in Table D-22:

Table D-22. Agriculture Water Use for the Choc-Pea Basin

HUC-8 Watershed	Agriculture - Surface Water	Agriculture - Groundwater
Upper Choctawhatchee	75%	25%
Lower Choctawhatchee	52%	48%
Pea	65%	35%
Average	64%	36%

Water quantity was analyzed for the entire basin using multiple methods. Extensive modeling at the HUC-8 watershed level was conducted using the WaSSI in conjunction with the DSSAT/GriDSSAT crop model. In addition to the WaSSI model, the tributaries within the basin were analyzed for runoff. Finally, the “irrigation density” analysis is used as a proxy to protect the smaller watersheds (HUC-12). Promoting expanded irrigation in HUC-12s that have less than 10 percent of the overall drainage areas as irrigated acres is recommended to protect local water supplies and existing irrigation investments. This is to further ensure impacts to local water resources are negligible to minor in intensity. Using these criteria, there is approximately 168,975 irrigated acre potential in the basin. Using the USGS data, this would equate to 108,144 surface water supplied acres and 60,831 groundwater supplied acres.

Groundwater and aquifers were analyzed using available information from both the Alabama Office of Water Resources and Geological Survey of Alabama. Further analysis was done to detail aquifer production areas as well as existing wells. This was completed to mitigate any potential impact to current groundwater users.

3.1. HUC-12 Irrigation Density Analysis (i.e. Sensitivity Analysis)

Due to the area of the basin and volume of water involved, the major concern is not about overall water supply but rather agricultural withdrawals on smaller tributaries where the withdrawals would represent a much larger fraction of the total flow. There are 111 HUC-12 watersheds in the basin and streamflow data is not available for all the potential project sites. To address this issue, irrigated acreage density (acres of irrigation as a ratio of total/HUC-12 acreage) has been mapped to the HUC-12 maps of the area. Any watershed where the irrigated acreage density exceeds 10 percent may be considered less than desirable for expanding irrigation using surface water supplies. This guideline is based on statewide modeling and research efforts (Srivastava et al., 2010). Using this guideline, assuming only dry agricultural land be converted to irrigated land and that irrigation expands uniformly across the HUC-12 watersheds, it is feasible to sustainably irrigate approximately 168,975 additional acres in the basin (see Table D-23 below). At this level, the impact to total surface water resources would be minor. This is considered a conservative threshold on irrigation expansion and does not incorporate the additional acreage expansion that could sustainably occur with groundwater, storage, or other mitigation practices.

Table D-23. HUC-12 Irrigation Density Acreage Analysis

HUC-12	HUC-12 Name	HUC-12 Area (ac)	Ag Land (ac)	Irrigated Ag Land (ac)	Percent Area Irrigated	10% of Total Area	Potential for Future Irrigated Ag Land (ac)
31402020409	Pea Creek-Whitewater Creek	20,668	1,431	0	0.00%	2,067	1,431
31402020501	Bowden Mill Creek	11,886	2,155	0	0.00%	1,189	1,189
31402020502	Danner Creek	23,661	3,956	0	0.00%	2,366	2,366
31402020503	Clearwater Creek	14,224	4,857	237	1.67%	1,422	1,185
31402020504	Huckleberry Creek	13,045	3,497	777	5.96%	1,305	527
31402020505	Turner Creek – Halls Creek	15,428	3,087	141	0.91%	1,543	1,402
31402020506	Cardwell Creek	25,927	2,378	111	0.43%	2,593	2,267
31402020507	Harpers Mill Creek	23,207	2,446	94	0.41%	2,321	2,227
31402020601	Beaver Dam Creek	19,234	2,066	16	0.08%	1,923	1,907
31402020602	Bucks Mill Creek	19,939	3,832	101	0.50%	1,994	1,893
31402020603	Helms Mill Creek	17,332	1,547	0	0.00%	1,733	1,547
31402020604	Hays Creek	10,850	3,667	16	0.15%	1,085	1,069
31402020605	Kimmy Creek	8,344	3,088	0	0.00%	834	834
31402020606	Pages Creek	9,478	4,246	64	0.68%	948	884
31402020607	Caney Branch – Cripple Creek	12,521	5,804	117	0.94%	1,252	1,135
31402020608	Holley Mill Creek	14,414	6,685	606	4.20%	1,441	835
31402020609	Bear Branch	14,389	5,188	819	5.69%	1,439	620
31402020610	Samson Branch	24,554	8,817	1,585	6.46%	2,455	870
31402020701	Cowhead Creek-Panther Creek	20,149	2,239	30	0.15%	2,015	1,985
31402020103	Hurricane Creek-Pea Creek	13,010	2,336	0	0.00%	1,301	1,301
31402020104	Pea Creek	22,825	3,634	203	0.89%	2,283	2,080
31402020201	Johnson Creek-Headwaters Pea River	27,369	2,941	280	1.02%	2,737	2,457
31402020202	Fishers lake-Spring Creek	7,094	673	0	0.00%	709	673

Table D-23. HUC-12 Irrigation Density Acreage Analysis

HUC-12	HUC-12 Name	HUC-12 Area (ac)	Ag Land (ac)	Irrigated Ag Land (ac)	Percent Area Irrigated	10% of Total Area	Potential for Future Irrigated Ag Land (ac)
31402020203	Little Indian Creek	14,416	1,182	0	0.00%	1,442	1,182
31402020204	Big Sandy Creek	11,577	525	0	0.00%	1,158	525
31402020205	Dry Creek-Pea River	27,519	2,918	622	2.26%	2,752	2,130
31402020206	Double Creek	16,052	618	0	0.00%	1,605	618
31402020207	Conners Creek	19,702	1,748	19	0.10%	1,970	1,729
31402020301	Buckhorn Creek	37,884	6,401	282	0.74%	3,788	3,507
31402020302	Sand Creek	19,696	3,256	117	0.59%	1,970	1,853
31402020303	Richland Creek	34,571	6,384	212	0.61%	3,457	3,245
31402020401	Persimmon Branch-Walnut Creek	28,096	4,635	266	0.95%	2,810	2,543
31402020402	Beaver Pond Branch	20,608	4,749	0	0.00%	2,061	2,061
31402020403	Mims Creek	32,506	5,694	0	0.00%	3,251	3,251
31402020404	Silers Mill Creek	7,020	2,291	0	0.00%	702	702
31402020405	Smart Branck-Big Creek	25,704	4,525	328	1.28%	2,570	2,242
31402020406	Stinking Creek-Bluff Creek	14,370	570	16	0.11%	1,437	554
31402020407	Sweetwater Creek-Big Creek	25,157	3,410	39	0.15%	2,516	2,477
31402020408	Jump Creek	28,337	3,180	0	0.00%	2,834	2,834
31402020702	Shotbag Creek-Flat Creek	37,402	11,000	398	1.06%	3,740	3,342
31402020101	Stinking Creek	12,808	1,073	32	0.25%	1,281	1,041
31402020102	Williams Mill Branch	18,648	2,290	309	1.66%	1,865	1,556
31402020905	Sandy Creek	19,574	6,370	272	1.39%	1,957	1,686
31402020906	Limestone Branch-Pea River	12,062	2,511	0	0.00%	1,206	1,206
31402020903	Limestone Creek	1,733	433	0	0.00%	173	173
31402020904	Hurricane Creek-Pea River	4,405	309	0	0.00%	440	309
31402020802	Corner Creek	33,385	7,031	95	0.28%	3,338	3,244
31402020803	Lower Eightmile Creek	18,274	4,568	213	1.16%	1,827	1,615

Table D-23. HUC-12 Irrigation Density Acreage Analysis

HUC-12	HUC-12 Name	HUC-12 Area (ac)	Ag Land (ac)	Irrigated Ag Land (ac)	Percent Area Irrigated	10% of Total Area	Potential for Future Irrigated Ag Land (ac)
31402020901	Gin Creek-Pea River	10,924	1,179	0	0.00%	1,092	1,092
31402010101	Headwaters East Fork Choctawhatchee River	19,913	5,137	593	2.98%	1,991	1,399
31402010102	Little Piney Woods Creek-Piney Woods Creek	12,589	1,947	0	0.00%	1,259	1,259
31402010103	Hamm Creek-Beaver Creek	20,984	5,673	0	0.00%	2,098	2,098
31402010104	Cowpens Creek-Indian Creek	17,313	1,885	0	0.00%	1,731	1,731
31402010201	Jack Creek	22,475	1,312	0	0.00%	2,247	1,312
31402010202	Poor Creek	13,277	1,939	12	0.09%	1,328	1,316
31402010203	Peebles Mill Creek-Panther Creek	11,982	1,582	0	0.00%	1,198	1,198
31402010204	Riley Creek	19,314	5,131	18	0.09%	1,931	1,913
31402010205	Little Blackwood Creek	17,516	10,975	968	5.53%	1,752	784
31402010303	Middle Judy Creek	18,627	1,662	0	0.00%	1,863	1,662
31402010304	Lower Judy Creek	22,556	2,176	80	0.35%	2,256	2,096
31402010401	Mill Branch-Lindsey Creek	25,787	4,992	352	1.36%	2,579	2,227
31402010402	Headwaters West Fork Choctawhatchee River	21,295	3,667	138	0.65%	2,130	1,992
31402010403	Sikes Creek	23,200	6,187	102	0.44%	2,320	2,218
31402010404	Upper West Fork Choctawhatchee River	13,940	3,509	0	0.00%	1,394	1,394
31402010405	Hopn Branch-Bear Creek	22,460	3,314	0	0.00%	2,246	2,246

Table D-23. HUC-12 Irrigation Density Acreage Analysis

HUC-12	HUC-12 Name	HUC-12 Area (ac)	Ag Land (ac)	Irrigated Ag Land (ac)	Percent Area Irrigated	10% of Total Area	Potential for Future Irrigated Ag Land (ac)
31402010206	Dunham Creek	10,818	4,600	546	5.04%	1,082	536
31402010207	Turkey Creek-Choctawhatchee River	14,264	4,817	319	2.23%	1,426	1,108
31402010208	Outlet East Fork Choctawhatchee River	21,609	7,628	248	1.15%	2,161	1,913
31402010301	Upper Judy Creek	14,300	2,189	0	0.00%	1,430	1,430
31402010302	Little Judy Creek	19,339	3,379	0	0.00%	1,934	1,934
31402010603	Brooking Mill Creek	16,675	1,954	293	1.76%	1,668	1,375
31402010604	Choctawhatchee Wells	7,234	757	0	0.00%	723	723
31402010701	Little Claybank Creek-Bear Creek	23,105	3,087	102	0.44%	2,311	2,209
31402010406	Middle West Fork Choctawhatchee River	29,579	3,032	0	0.00%	2,958	2,958
31402010407	Lower West Fork Choctawhatchee River	15,979	2,751	0	0.00%	1,598	1,598
31402010501	Newton Creek	25,494	8,559	68	0.26%	2,549	2,482
31402010502	Sasser Branch-Bear Creek	16,049	8,603	61	0.38%	1,605	1,544
31402010503	Murphy Mill Branch-Little Choctawhatchee River	26,416	9,989	680	2.57%	2,642	1,962
31402010504	Panther Creek-Little Choctawhatchee River	35,047	17,536	856	2.44%	3,505	2,649
31402010601	Klondike Creek-Hurricane Creek	17,339	1,682	0	0.00%	1,734	1,682
31402010602	Killebrew Factory Creek	10,428	3,229	0	0.00%	1,043	1,043

Table D-23. HUC-12 Irrigation Density Acreage Analysis

HUC-12	HUC-12 Name	HUC-12 Area (ac)	Ag Land (ac)	Irrigated Ag Land (ac)	Percent Area Irrigated	10% of Total Area	Potential for Future Irrigated Ag Land (ac)
31402011004	Cox Mill Creek-Hurricane Creek	15,706	6,520	324	2.06%	1,571	1,247
31402011101	Little Double Bridges Creek	13,649	5,322	0	0.00%	1,365	1,365
31402011102	Blanket Creek-Double Bridges Creek	26,982	8,077	44	0.16%	2,698	2,654
31402011103	Tight Eye Creek	27,688	11,135	736	2.66%	2,769	2,033
31402011104	Beargrass Creek	20,246	6,326	313	1.54%	2,025	1,712
31402011105	Bushy Branch-Double Bridges Creek	16,505	6,082	673	4.08%	1,651	978
31402011106	Long Branch-Double Bridges Creek	19,644	7,841	950	4.83%	1,964	1,015
31402011201	Wilkerson Creek	23,185	11,217	772	3.33%	2,319	1,547
31402011003	Sconyers Branch	10,045	2,260	0	0.00%	1,004	1,004
31402011202	Campbell Mill Creek	28,883	11,661	1,125	3.90%	2,886	1,761
31402010802	Steep Head Creek	8,553	1,668	0	0.00%	855	855
31402010803	Blacks Mill Creek	13,676	590	0	0.00%	1,368	590
31402010901	Harrand Creek	13,139	1,737	0	0.00%	1,314	1,314
31402010902	Little Cowpen Creek-Cowpen Creek	9,047	2,315	46	0.50%	905	859
31402010903	Middle Clay Bank Creek	10,225	521	0	0.00%	1,023	521
31402010904	Lower Clay Bank Creek	23,062	7,064	406	1.76%	2,306	1,900
31402011001	Pine Log Branch	19,564	7,872	245	1.25%	1,956	1,711
31402011002	Pates Creek	12,093	5,809	371	3.07%	1,209	838
31402011203	Rocky Creek-Adams Creek	19,325	7,040	467	2.41%	1,933	1,466
31402010702	Headwaters Clay Bank Creek	23,145	3270	235	1.01%	2,315	2,080
31402010703	Upper Clay Bank Creek	7,208	126	0	0.00%	721	126
31402010801	Bowles Creek	18,933	1,694	0	0.00%	1,893	1,694

Table D-23. HUC-12 Irrigation Density Acreage Analysis

HUC-12	HUC-12 Name	HUC-12 Area (ac)	Ag Land (ac)	Irrigated Ag Land (ac)	Percent Area Irrigated	10% of Total Area	Potential for Future Irrigated Ag Land (ac)
31402030101	Justice Mill Creek	9,165	5,489	565	6.17%	916	361
31402030102	Upper Spring Creek	10,809	4,066	478	4.42%	1,081	603
31402030103	Spring Creek-Choctawhatchee River	14,162	4,494	271	1.91%	1,416	1,145
31402030104	Parrot Creek	668	140	0	0.00%	67	67
31402030105	East Pittman Creek-Choctawhatchee River	4,647	1,445	119	2.57%	465	345
31402030201	Upper Wrights Creek	22,331	9,475	160	0.72%	2,233	2,073
31402030203	Tenmile Creek	7,198	2,353	17	0.24%	720	703
31402030701	Big Branch-Holmes Creek	10,329	3,988	8	0.07%	1,033	1,025
	Total	**1,988,673**	**461,895**	**22,171**	**1.11%**	**198,867**	**168,975**

3.2. Integrated Crop-Hydrology Model for the Choc-Pea Basin

In order to evaluate the impacts that increased irrigation would have on the water resources of the basin, an integrated model of the hydrology and agricultural water demand is necessary. The Water Supply Stress Index (WaSSI) model developed by the Eastern Forest Environmental Threat Assessment Center of the USDA Forest Service (Sun et al., 2008; Caldwell et al., 2012) forms the hydrologic component of the coupled model. The Water Supply Stress Index is defined simply as the ratio of the total water demand for a period of time in a basin to the total water supply for that time (including return flows from all withdrawals).

The WaSSI model is composed of a hydrologic model to compute the water supply term together with a module to estimate water demand for the HUC. The hydrologic model computes the water balance for each of ten land cover classes independently in each HUC watershed. Evapotranspiration (ET), infiltration, soil storage, snow accumulation and melt, surface runoff, and baseflow processes are calculated in each basin based on spatially explicit 2001 MODIS land cover, and discharge (Q) is instantaneously routed through the stream network from upstream to downstream watersheds. ET is estimated with an empirical equation based on multisite eddy covariance ET measurements using MODIS derived monthly leaf area index (LAI), potential ET (PEThamon), and precipitation (PPT) as independent variables (Sun et al., 2011). PET by Hamon's method is computed using only the daylight hours in the month (related to the mean latitude of the HUC) and the saturated vapor density computed from the mean monthly temperature (Hamon, 1963). Estimation of infiltration, soil storage, base flow and runoff are accomplished through algorithms from the Sacramento Soil Moisture Accounting Model.

As originally constituted by the National Forest Service, the model did not include streamflow regulation by reservoirs. However, due to their ability to provide water yields to downstream HUCs, reservoirs are important in reflecting stress especially during the growing season. Consequently, we have added all of the reservoirs in Alabama to the model. The regulation effects are simulated through the incorporation of the area-capacity and operating (rule) curve relationships for the reservoirs of significant size to impact streamflow at the 8-digit HUC level. Inflow to the reservoir is computed by the WaSSI hydrologic model and the resulting reservoir elevation is computed from the area-capacity relationship. The operating curve is then consulted to determine the desired elevation for the time of year and the required reservoir release is computed to bring the reservoir back to its desired elevation.

The water demand component of the WaSSI model uses county-level 2010 annual U.S. Geological Survey (USGS) water demand and groundwater withdrawal estimates for eight water use sectors (Kenny et al., 2009). The sectors include domestic use, industrial demand, public needs, irrigation, mining, livestock, thermoelectric power, and aquaculture.

In order to model the dynamic irrigation demand sector for WaSSI, a coupled model is necessary. The Decision Support System for Agrotechnology Transfer (DSSAT v4.5) model (Jones et al., 2003; Hoogenboom et al., 2010) is a framework for biophysical modeling that includes a suite of more than 20 different cropping and fallow system models. DSSAT simulates crop growth and yield in response to management, climate, and soil conditions and requires a minimum set of inputs such as a variety of weather, soil type and profile variables, cultivar specific parameters and field management strategies including planting dates, irrigation and fertilization. In use for over 25 years, this widely used crop model has been applied to predict crop yield and water use, to develop management strategies, and to study nitrogen cycling dynamics under many different soil and climate scenarios (Liu et al., 2011; Soler et al., 2011; Thornton at al., 2009; Soler et al., 2007; Yang et al., 2006; Jones et al., 2003).

The DSSAT crop model was designed to analyze a wide variety of agricultural impacts, but was originally conceived for a point or field scale. A spatial model becomes necessary when analyzing water resources at the watershed, state, and regional level. Thus, the DSSAT system was configured to run in a gridded mode at a grid spacing of approximately 4.75 km. This gridded crop model is referred to as "GriDSSAT" (McNider et al., 2011). An input data file that defines the location, weather, cultivar soil type, and other input parameters for each grid cell was developed. A batch process then runs DSSAT for every point in the grid. GriDSSAT is configured to run in a real-time daily mode or in a historic weather data mode. Both modes require the model to process over 36,000 points for every day in a growing season to cover most of the Southeastern region.

In the broad geographic context of GriDSSAT, the selection of the cultivar is different than in a specific field mode. We must have cultivar characteristics which broadly mimic the type of cultivars that are employed across the region perhaps at the expense of the specific cultivar response at the field level. As such, an initial cultivar was developed in a field mode but one that had generic attributes of a broad range of cultivars. Next, a regional test of the cultivar was made at locations across a broad range of soils and weather. Finally, the model was evaluated against southeast regional NASS county level crop data.

The cultivar-specific coefficients were modified by generalized likelihood uncertainty estimation (Beven and Binley, 1992) to determine a set of coefficients that reduced the difference between simulated and observed grain yield and anthesis date resulting in a best fit (lowest root mean square error (RMSE)) for the experimental corn cultivar used.

The base cultivar used in GriDSSAT was calibrated against field trial yield data conducted at the Tennessee Valley Research and Extension Center (TVREC) located in BelleMina, Alabama -an agricultural experiment station operated by the Auburn University Agricultural Extension Service. Dynagrow 58K02 was selected as the TVREC target cultivar with six irrigating years (2004-2009) of data available (observed standard deviation = 159 kg/ha (20 bu/ac)). The Dynagrow 58K02 hybrid fit the overall corn average of the TVREC Variety Trials for both irrigated and rainfed trials well with a coefficient of determination of 0.9609 and an RMSE of 647 kg/ha (10 bu/ac, which represents eight percent of the mean). Crop management profiles were created for each of the six years of data from the Variety Trial report and the soil used a silty clay loam representative of the TVREC fields. A medium to full season default corn hybrid cultivar (McCurdy 84aa) was selected as the base cultivar for calibration as it was well suited to the area and has been used in previous studies in the Southeastern United States (Cabrera et al., 2007; Ma et al., 2006; 2009). The goal of the calibration process was to derive a set of parameters for the McCurdy 84aa cultivar that would best mimic the target (Dynagrow 58K02) cultivar.

The results of the DSSAT model calibration yield are shown in Figure D-12. The yield calibration resulted in a coefficient of determination of 0.7235 and an RMSE of 817 kg/ha (13 bu/ac, eight percent). The means for the observed and simulated grain weights were 10,184 kg/ha (161 bu/ac) and 10,586 kg/ha (168 bu/ac) respectively. The higher variance in the observed data suggests water and nitrogen stressors were present in the irrigated trials. Cultivar coefficients are best calibrated under optimal growing conditions with no stress. However, considering the assumption of unequal variances, a t-test of the observed and simulated yields suggests that the difference of the means is not significant with a P-value of 0.532.

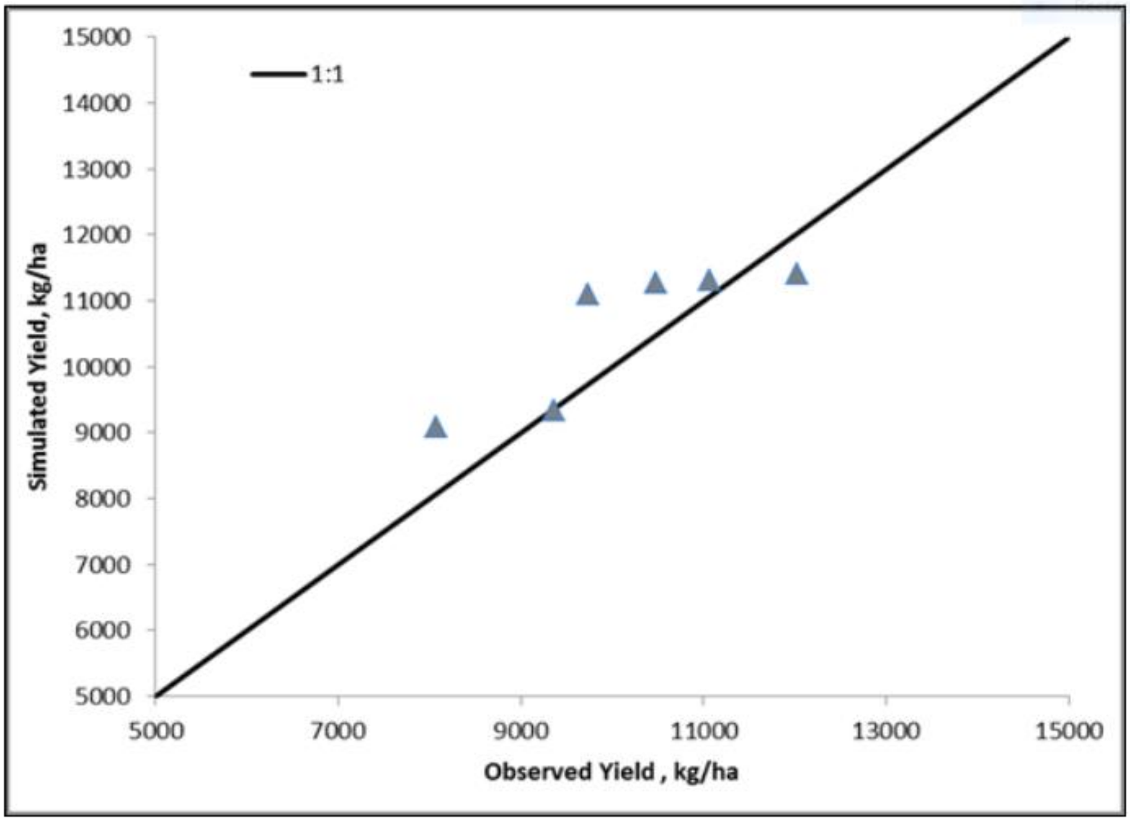

Figure D-12: Cultivar Calibration Results for 2004-2009: DSSAT Simulated Yields Compared to Observed TVRC Variety Trial Yields of DynaGro 58K02

3.3. Average Yields Simulation

The next step was to evaluate the performance of the calibrated cultivar in simulating the overall yield averages in the region. To achieve this, 11 years (2000-2011) of Alabama Corn Hybrid Variety Trials from Auburn University Agricultural Extension Service's TVREC, and the Sand Mountain Research and Extension Center (SMREC) at Crossville, AL were employed. Irrigated and rainfed trial averages were used from TVREC while only rainfed trials were available at SMREC. The results of the evaluations can be seen in Figure D-13. The model performed well in simulating the measured regional variety trial averages. The coefficient of determination for the evaluation was 0.7887 and a RMSE of 1,603 kg/ha (25 bu/ac, 19 percent). The regression slope was 0.9968 with an intercept of 848 kg/ha.

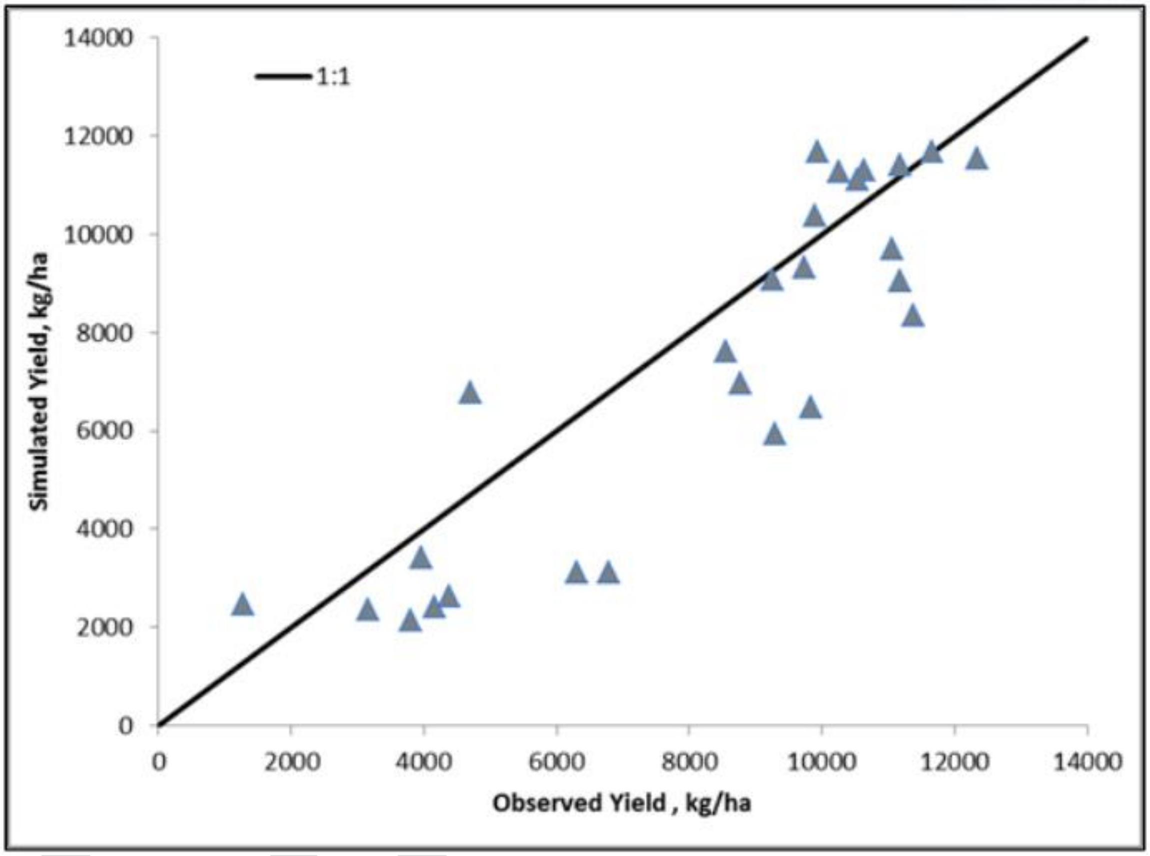

Figure D-13: Cultivar Evaluation Results for 2000-2011: DSSAT Simulated Yields Compared to Observed TVRC and SMREC Variety Trial Average Yields

We execute the model using irrigation demands supplied by GriDSSAT. Note that in the present version we are using corn as the surrogate crop for irrigation demand. This means that we assume all land defined by CropScape is currently in production for corn. Corn is used as a proxy for all irrigated crops because it usually requires the most water of all row crops grown in the Southeast.

3.4. Hydrologic Modeling Methodology

The WASSI model has been evaluated for all of the HUC-8 watersheds in Alabama, either using observed long-term gage data where available or the data contained in the AL Office of Water

Resources resource evaluation. Suitable gages for the Choctawhatchee exist near Bellwood, Alabama and Caryville, FL. The WASSI comparison to the monthly data at the gage is shown in Figure D-14 and Figure D-15.

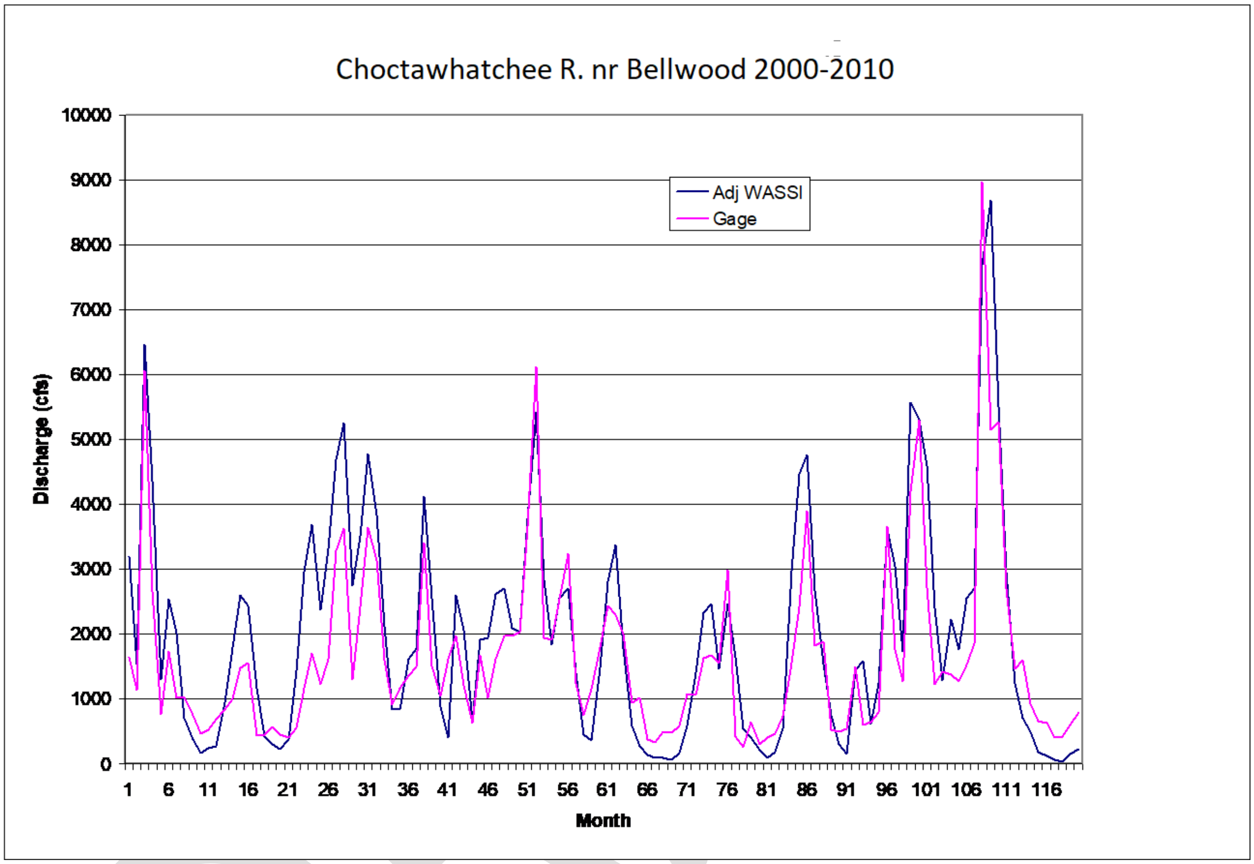

Figure D-14: The WASSI Comparison to the Monthly Data at the Gage

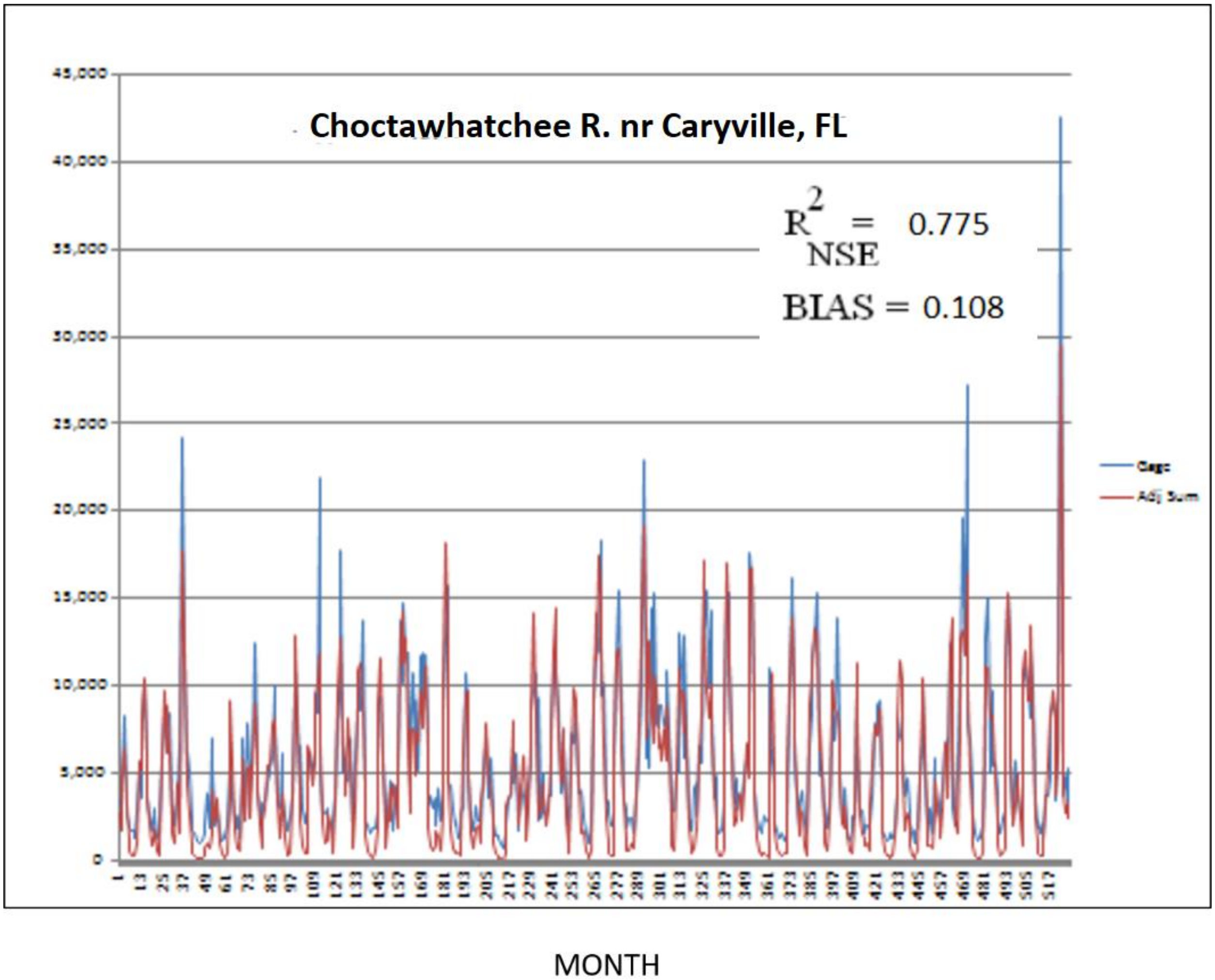

Figure D-15: The WASSI Comparison to the Monthly Data at the Gage

The effectiveness of hydrologic models is usually quantified through the model bias and a measure of model error known as the Nash-Sutcliffe Efficiency Statistic (R2NSE). The R2NSE is essentially a ratio of the model error to the variance of the observed data and thus serves to represent a measure of model variability compared to the variability of the observations. Some authors suggest that the R2NSE values as low as 0.50 are acceptable while a more common metric is the R2NSE greater than 0.70. In our case, the R2NSE value is 0.78 and the model bias is 0.108. Thus, a bias of less than 10 percent and a Nash-Sutcliffe value of greater than 0.70 would indicate a generally good fit to the streamflow observations.

3.5. Results of Choc-Pea WaSSI Modeling

The coupled crop-hydrology model results are reported below. The results are based on data covering the “weather years” 1915 to 2011. This time period covers a wide variety of conditions that are representative of conditions that could be experienced in the future.

3.5.1. Irrigation Demand

The model provides irrigation demand over the region. Figure D-16 depicts long-term average monthly irrigation demand.

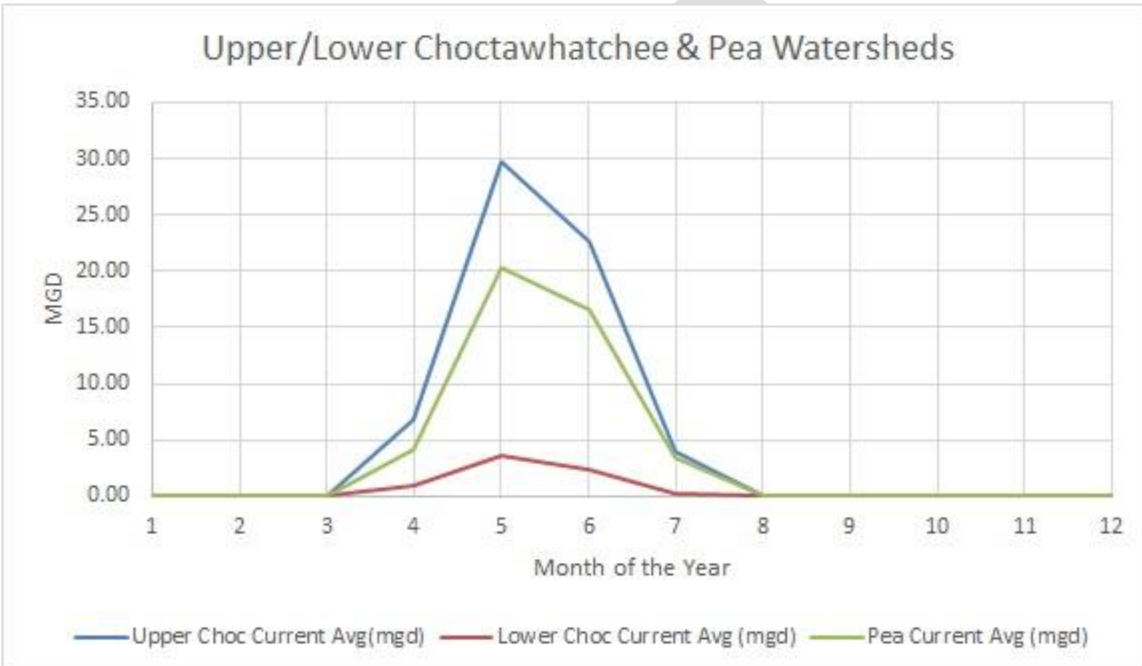

Figure D-16: Irrigation Demand for the Choc-Pea Basin

3.5.2. Model Irrigation Demand compared to OWR Assessment Data

The “2017 Alabama Surface Water Assessment Report” provides a snapshot of monthly agricultural demand for 2010 and estimates the future demand in 2040. The data is reported at the HUC-8 watershed scale within the state. Looking at current data from the three HUC-8 watersheds and comparing it with the model data provides confidence that the model is capturing most of the irrigation demand. Discrepancies are attributed to the fact that the assessment is only a snapshot of one year and a projection; it includes other water demands not modelled (like golf courses and livestock). Also, the model is based on a standard growing season where planting dates vary for multiple crops. Figures D-17, D-18, and D-19 include the assessment and model data for each watershed.

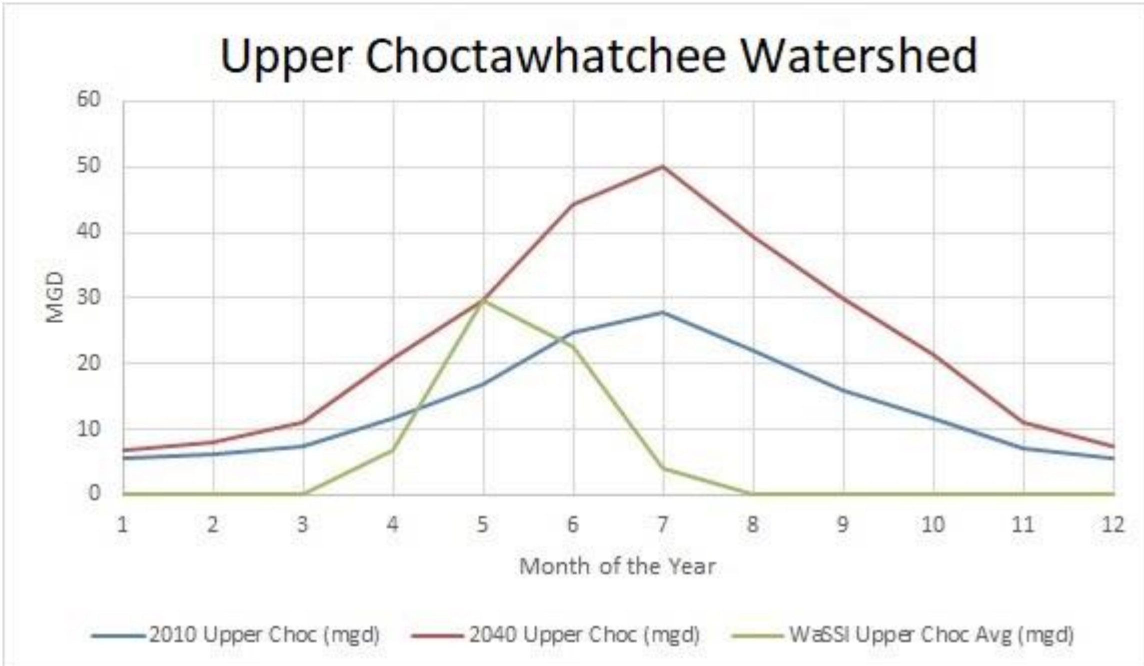

Figure D-17: Upper Choctawhatchee Irrigation Demand Model compared to OWR Assessment Data

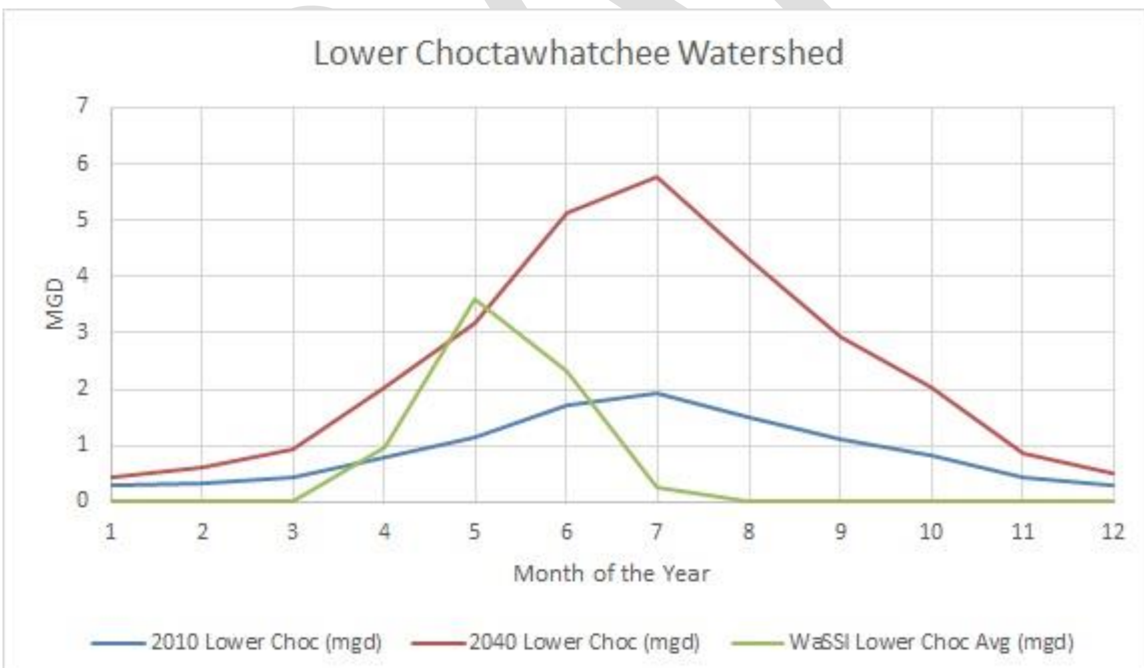

Figure D-18: Lower Choctawhatchee Irrigation Demand Model compared to OWR Assessment Data

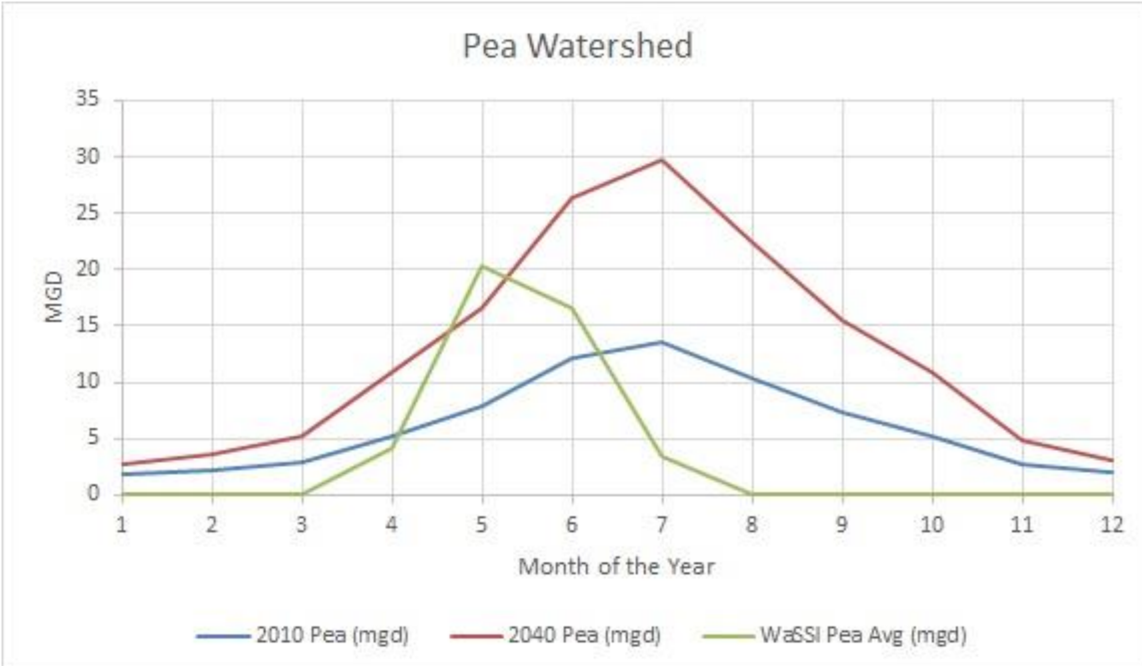

Figure D-19: Pea Watershed
Irrigation Demand Model Compared to OWR Assessment Data

3.5.3. Model Scenario Results

The model is useful not only in understanding the current impact irrigation may have but in looking forward to understanding how irrigation growth may impact water resources. By expanding the acres irrigated in the model, water demand goes up. Increasing acreage to the 10 percent scenario as well as irrigating all agricultural land in the basin and reporting the results shows the relative impact increasing irrigation may potentially have on water resources. Figures D-20, D-21, and D-22 include the assessment and model data for each watershed under these scenarios.

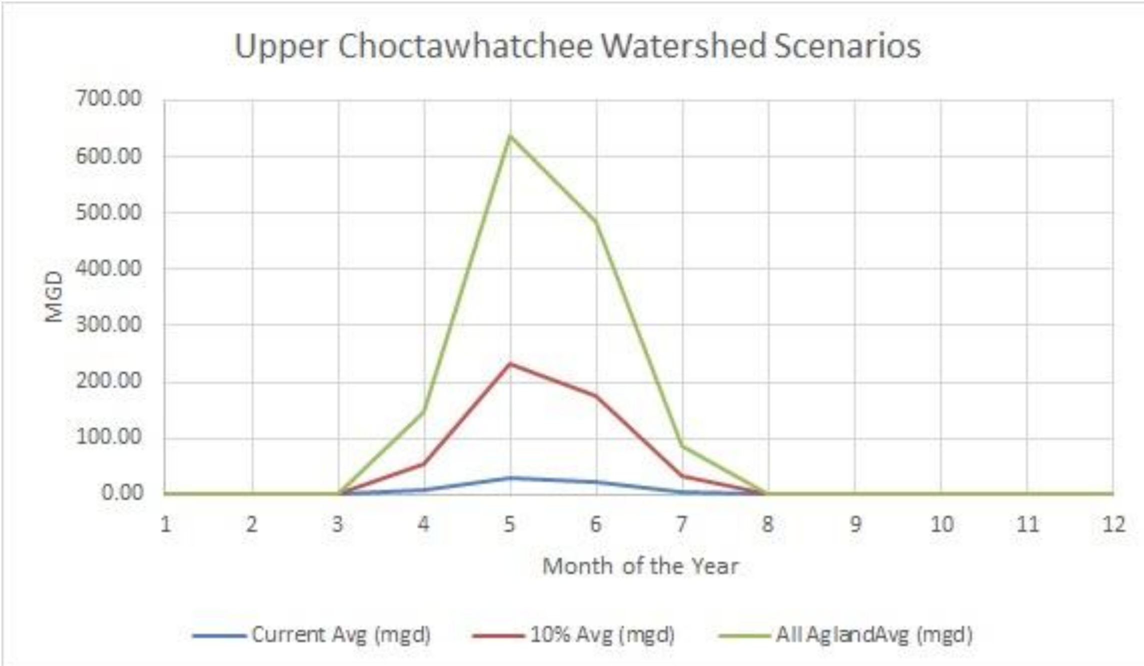

Figure D-20: Upper Choctawhatchee- Irrigation Impact Scenarios

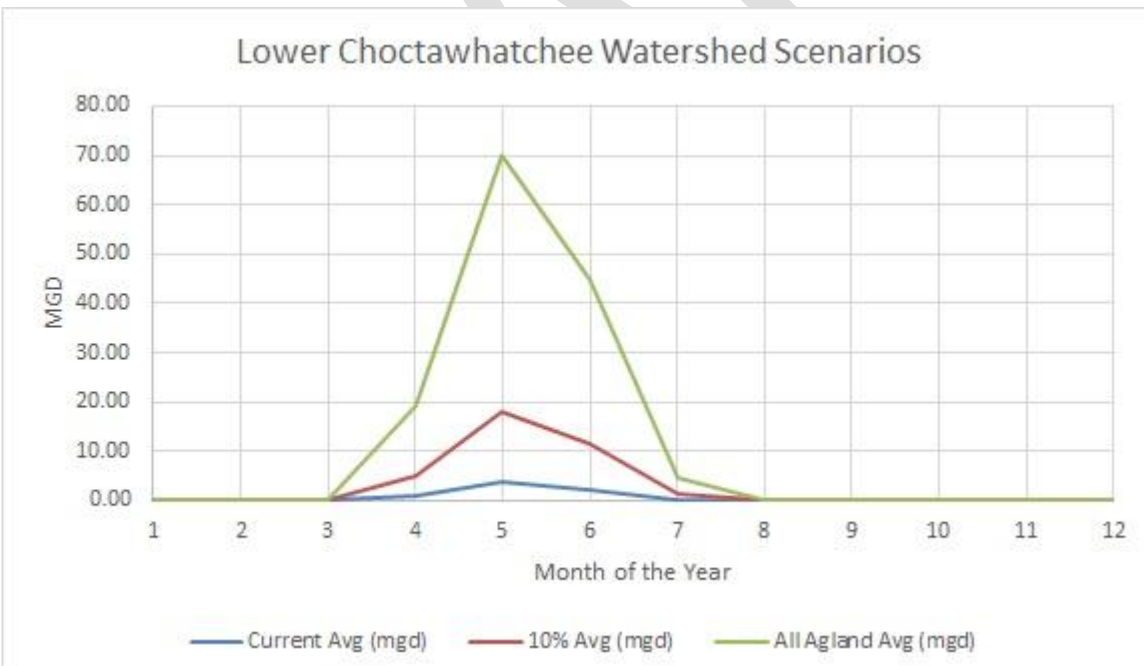

Figure D-21: Lower Choctawhatchee- Irrigation Impact Scenarios

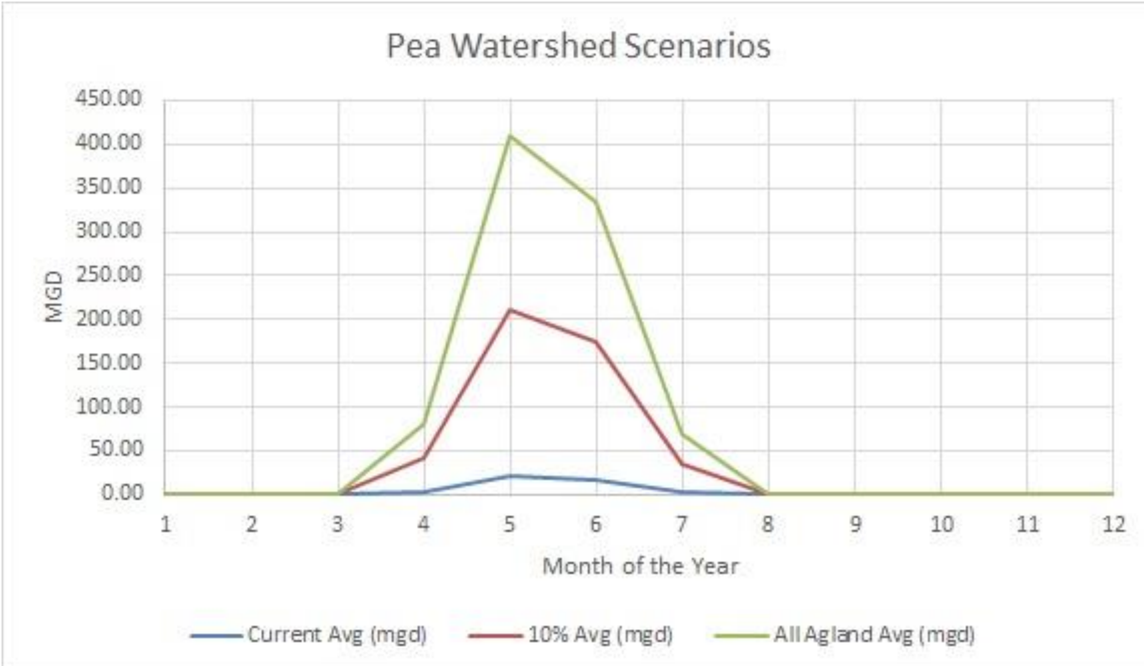

Figure D-22: Pea Watershed- Irrigation Impact Scenarios

The model estimates increasing irrigated acreage by 10 percent in the watershed would increase the irrigation demand by about four millions of gallons per day (MGD) during the peak month. Increasing irrigated acreage by 25 percent would increase irrigation demand by about 10 MGD. This change in irrigation demand reduces overall flow out of the watershed, which should be reflected in the WaSSI. The index is best understood as the percent (or fraction) of available water that is consumed. The closer the index is to "1", the closer consumption is to available water in the watershed. Thus, an index of "0.10" means only 10 percent of the water in the shed is consumed. The USFS set a maximum index at 0.40 (or 40 percent consumption). Analyzing long term results, we count the number of months the WaSSI exceeds the index value. For comparison, the model is run with NO Irrigation, CURRENT Irrigation, THRESHOLD Irrigation (10 percent of the watershed area) and ALL agricultural land. The results show that current irrigation only increases the time the index is above 40 by approximately 0.61 percent. Increasing irrigated acreage to 10% of the basin area would increase the time by 6.2 percent over the current conditions for the Upper Choctawhatchee, which would be classified as a minor effect. Even if all the agricultural land were irrigated, the number of months above the 40 index would be 12.6 percent for the Upper Choctawhatchee, which would be classified as a moderate effect. Table D-24 shows the percent time the WaSSI is above/below the threshold of 40 percent.

Table D-24. The Percent of Time the WaSSI Exceeds the Threshold

HUC	HUC Name	NO IRR Months>40%	CURRENT Months>40%	Threshold Months>40%	All Agland Months>40%
3140201	Upper Choc	2.08%	2.69%	8.85%	15.28%
3140202	Pea	1.22%	1.65%	8.25%	12.41%
3140203	Lower Choc	0.17%	0.17%	0.52%	2.86%

3.6. Surface Water Extreme Scenarios

An analysis of the gauged tributaries in the Upper Choctawhatchee and Pea Watersheds were analyzed and returned an annual average runoff of 17.9 and 18.9 inches, respectively.

3.6.1. Current Irrigated Land Scenarios

Assuming an average case scenario of the surface water irrigation demand in the Upper Choctawhatchee and Pea watersheds is 75 percent and 65 percent, respectively. If all the current irrigated land in the basin used runoff originating in the basin and at the average demand estimate, it would be 0.30 percent and 0.18 percent of total annual runoff for the Choctawhatchee and Pea watersheds respectively. Current irrigation demand, while not negligible, is very minor in intensity.

3.6.2. 10 Percent Irrigated Land Scenarios

Assuming an average case scenario where 75 percent and 65 percent of the irrigation demand for the Upper Choctawhatchee and Pea watersheds, respectively, came from surface water. If the 10 percent irrigated land scenario is approximately 192,766 acres (current irrigated plus potential future irrigated agricultural land up to the 10 percent scenario) in the basin and at the average demand estimate, it would be 2.3 percent and 1.9 percent of total annual runoff for the Choctawhatchee and Pea watersheds, respectively. Ten percent irrigation demand would be classified as minor intensity.

3.6.3. All Agricultural Land Irrigated Land Scenarios

Assuming an average case scenario where 75 percent and 65 percent of the irrigation demand for the Upper Choctawhatchee and Pea watersheds, respectively, came from surface water. If all the agricultural land is irrigated (461,895 acres) in the basin and at the average demand estimate, it would be 6.3 percent and 3.6 percent of total annual runoff for the Choctawhatchee and Pea watersheds, respectively. Threshold irrigation demand would be classified as minor intensity.

3.7. Groundwater and Aquifer Results

Using withdrawal data provided in the OWR assessment (Harper et al., 2015), irrigation withdrawals are put into context relative to other sectors use. Using the aquifer area and recharge data provided by the GSA along with irrigation location and demand data, a sensitivity model was built to analyze the impact of current and future irrigation on groundwater resources. The current irrigated acreage is already defined, and the threshold irrigated acreage is based on the irrigation density analysis. In the extreme scenario, all agricultural land is used as the upper limit of possible irrigated acreage.

3.7.1 Watershed Withdrawal Budgets

The OWR assessment breaks down groundwater withdrawals by month and sector. When reviewing all sectors, groundwater is the dominant source of water in the basin (73 percent). The following table shows the watershed withdrawal budgets by month (Table D-25).

Table D-25. Watershed Withdrawal Budget

Month	Basin All Withdrawals (MGD)	Basin All Withdrawals (in)	Basin GW Withdrawals (MGD)	Basin GW Withdrawals (in)	GW Percentage of ALL Withdrawals
Jan	36.68	0.0207	30.72	0.0173	83.75%
Feb	37.34	0.0190	30.68	0.0156	82.16%
March	43.38	0.0245	35.19	0.0199	81.12%
April	50.32	0.0275	37.31	0.0204	74.15%
May	61.77	0.0349	43.62	0.0246	70.62%
June	75.61	0.0413	49.2	0.0269	65.07%
July	79.88	0.0451	50.35	0.0284	63.03%
Aug	71.76	0.0405	48.04	0.0271	66.95%
Sept	64.48	0.0352	46.64	0.0255	72.33%
Oct	52.09	0.0294	38.86	0.0219	74.60%
Nov	40.72	0.0223	32.7	0.0179	80.30%
Dec	37.73	0.0213	31.58	0.0178	83.70%
Total	**651.76**	**0.3618**	**474.89**	**0.2635**	**72.86%**

However, when analyzing just the agricultural sector, it appears the major source of irrigation is surface water with the demand being at (64 percent) while the groundwater demand is only (36 percent). The following tables break it down by the major watersheds in the basin (Tables D-26, D-27, and D-28).

Table D-26. Upper Choctawhatchee River - Demand Data (2010)**2010 Demands- Upper Choctawhatchee River**

Withdrawals (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	**Percentage**
Agriculture-GW	0.81	1.05	1.36	2.57	4.48	7.56	8.45	6.18	3.65	2.40	1.15	0.86	3.38	25%
Agriculture-SW	4.62	5.05	6.11	9.20	12.32	17.32	19.36	15.95	12.40	9.36	6.07	4.71	10.21	75%
Ag-Total	5.43	6.10	7.47	11.77	16.80	24.88	27.81	22.13	16.05	11.76	7.22	5.57	13.59	100%
Total-SW	**4.68**	**5.11**	**6.17**	**9.26**	**12.38**	**17.38**	**19.42**	**16.01**	**12.46**	**9.42**	**6.13**	**4.77**	**10.26**	**27%**
Total-GW	**20.75**	**20.77**	**24.97**	**25.36**	**30.37**	**34.33**	**34.72**	**33.25**	**32.70**	**26.77**	**22.30**	**21.69**	**27.33**	**73%**
Total	**25.43**	**25.88**	**31.14**	**34.62**	**42.75**	**51.71**	**54.14**	**49.26**	**45.16**	**36.19**	**28.43**	**26.46**	**37.59**	**100%**
Ag GW%	**4%**	**5%**	**5%**	**10%**	**15%**	**22%**	**24%**	**19%**	**11%**	**9%**	**5%**	**4%**		
Ag SW%	**99%**	**99%**	**99%**	**99%**	**100%**	**100%**	**100%**	**100%**	**100%**	**99%**	**99%**	**99%**		
Returns (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Returns	22.80	25.96	17.56	13.92	15.30	14.62	14.35	14.76	12.85	12.76	13.96	12.61	15.95	

Table D-27. Pea River - Demand Data (2010)

2010 Demands- Pea River														
Withdrawals (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	**Percentage**
Agriculture- GW	0.75	0.86	1.11	1.92	2.67	3.96	4.41	3.42	2.57	1.94	1.07	0.82	2.12	35%
Agriculture-SW	1.10	1.34	1.76	3.30	5.14	8.11	9.09	6.91	4.78	3.34	1.64	1.18	3.97	65%
Ag-Total	1.85	2.20	2.87	5.22	7.81	12.07	13.50	10.33	7.35	5.28	2.71	2.00	6.09	100%
Total -SW	**1.13**	**1.37**	**1.78**	**3.33**	**5.17**	**8.14**	**9.12**	**6.94**	**4.81**	**3.37**	**1.66**	**1.21**	**4.00**	**27%**
Total-GW	**9.10**	**9.10**	**9.33**	**10.82**	**11.88**	**13.12**	**13.82**	**13.24**	**12.54**	**10.97**	**9.48**	**9.03**	**11.03**	**73%**
Total	**10.23**	**10.47**	**11.11**	**14.15**	**17.05**	**21.26**	**22.94**	**20.18**	**17.35**	**14.34**	**11.14**	**10.24**	**15.03**	**100%**
Ag GW%	**8%**	**9%**	**12%**	**18%**	**22%**	**30%**	**32%**	**26%**	**20%**	**18%**	**11%**	**9%**		
Ag SW%	**97%**	**98%**	**99%**	**99%**	**99%**	**100%**	**100%**	**100%**	**99%**	**99%**	**99%**	**98%**		
Returns (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Returns	8.48	7.87	7.79	6.96	6.41	6.36	5.94	6.74	5.98	6.38	6.14	6.51	6.80	

Table D-28. Lower Choctawhatchee River - Demand Data (2010)

2010 Demands- Lower Choctawhatchee River														
Withdrawals (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	**Percentage**
Agriculture-GW	0.13	0.16	0.21	0.39	0.56	0.84	0.94	0.72	0.54	0.40	0.20	0.14	0.44	48%
Agriculture-SW	0.15	0.18	0.23d.2	0.42	0.59	0.89	1.00	0.77	0.57	0.42	0.22	0.17	0.47	52%
Ag-Total	0.28	0.34	0.44	0.81	1.15	1.73	1.94	1.49	1.11	0.82	0.42	0.31	0.91	100%
Total-SW	**0.16**	**0.18**	**0.24**	**0.43**	**0.60**	**0.90**	**1.00**	**0.77**	**0.58**	**0.43**	**0.23**	**0.17**	**0.47**	**28%**
Total-GW	**0.87**	**0.81**	**0.89**	**1.13**	**1.37**	**1.75**	**1.81**	**1.55**	**1.40**	**1.12**	**0.92**	**0.86**	**1.21**	**72%**
Total	**1.03**	**0.99**	**1.13**	**1.56**	**1.97**	**2.65**	**2.81**	**2.32**	**1.98**	**1.55**	**1.15**	**1.03**	**1.68**	**100%**
Ag GW %	**15%**	**20%**	**24%**	**35%**	**41%**	**48%**	**52%**	**46%**	**39%**	**36%**	**22%**	**16%**		
Ag SW %	**94%**	**100%**	**96%**	**98%**	**98%**	**99%**	**100%**	**100%**	**98%**	**98%**	**96%**	**100%**		
Returns (MGD)														
Category	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**AVG**	
Agriculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Returns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

3.7.2. Aquifer Recharge Analysis Results

The impact of irrigation demand on aquifer levels is analyzed by determining the percentage of recharge that is consumed within the aquifer. Three scenarios are analyzed, each scenario assumes 36% of total irrigation demand is groundwater, while 64% is surface water. Each scenario is also based on the Maximum, Minimum and Average irrigation demand based on the long-term crop model runs. Recharge data was available for four of the six aquifers analyzed in the basin. The first scenario is current irrigated acreage and the related demand in the aquifer production zone (Table D-29). The second scenario assumes 10 percent of the total aquifer production zone (Table D-30) area is irrigated (the threshold guideline). The third scenario assumes all agricultural land occurring within the aquifer production zone (Table D-31) is irrigated. Aquifers in this basin overlap one another and it is challenging to estimate from which aquifer a particular withdrawal is occurring. Therefore, it is assumed that all withdrawals over a particular aquifer production zone occur in that aquifer. This is calculated and reported for every aquifer separately. In reality this is not likely but even under these hypothetical scenarios, aquifers experience only negligible to minor impacts.

Current average irrigation demand in the aquifer production zone is less than 1 percent of any aquifer recharge, which is considered negligible. Projecting into the future if 10 percent of the aquifer production zone is irrigated (the 10 percent threshold guideline), the average irrigation demand for all aquifers considered productive would remain under 10 percent of recharge. This would be classified as a minor impact. Assuming all agricultural land in the aquifer production zone were irrigated, the recharge range would be between 13 percent and 15 percent for the six aquifers considered productive. This would be classified as moderate impact.

Table D-29. Current Average Irrigation Demand in Aquifer Production Zones as a Percentage of Total Recharge (First Scenario)

Current Irrigated Land														
AQUIFER	Production Area (ac)	Irrigated Acreage (ag)	MAX IRR Demand (acft)	MIN IRR Demand (acft)	AVG IRR Demand (acft)	MAX IRR Demand (in)	MIN IRR Demand (in)	AVG IRR Demand (in)	MAX IRR Demand 36% (in)	MIN IRR Demand 36% (in)	AVG IRR Demand 36% (in)	MAX % Recharge (@36%)	MIN % Recharge (@36%)	AVG % Recharge (@36%)
Clayton	646,877	7,327	7,710	483	3,623	0.143	0.009	0.067	0.051	0.003	0.024	1.39%	0.09%	0.65%
Gordo	988,368	5,136	5,463	444	2,461	0.066	0.005	0.030	0.024	0.002	0.011			
Nanafalia aquifer	863,114	16,037	16,821	797	7,678	0.234	0.011	0.107	0.084	0.004	0.038	1.68%	0.08%	0.77%
Ripley Cusseta	730,536	6,223	6,723	458	3,025	0.110	0.008	0.050	0.040	0.003	0.018	1.53%	0.10%	0.69%
Salt Mtn	1,020,978	16,465	17,272	823	7,873	0.203	0.010	0.093	0.073	0.003	0.033			
Tallahatta	777,774	16,149	16,925	787	7,669	0.261	0.012	0.118	0.094	0.004	0.043	1.88%	0.09%	0.85%

Table D-30. Threshold Irrigation Demand in Aquifer Production Zones as a Percentage of Total Recharge (Second Scenario)

10% Threshold Irrigated Land														
AQUIFER	Production Area (ac)	Irrigated Acreage (ag)	MAX IRR Demand (acft)	MIN IRR Demand (acft)	AVG IRR Demand (acft)	MAX IRR Demand (in)	MIN IRR Demand (in)	AVG IRR Demand (in)	MAX IRR Demand 36% (in)	MIN IRR Demand 36% (in)	AVG IRR Demand 36% (in)	MAX % Recharge (@36%)	MIN % Recharge (@36%)	AVG % Recharg (@36%
Clayton	646,877	62,303	64,153	3,451	29,355	1.190	0.064	0.545	0.428	0.023	0.196	11.58%	0.62%	5.30%
Gordo	988,368	94,390	100,827	7,188	45,206	1.224	0.087	0.549	0.441	0.031	0.198			
Nanafalia aquifer	863,114	85,988	87,859	3,958	39,787	1.222	0.055	0.553	0.440	0.020	0.199	8.79%	0.40%	3.98%
Ripley Cusseta	730,536	69,809	74,070	4,200	32,448	1.217	0.069	0.533	0.438	0.025	0.192	16.85%	0.96%	7.38%
Salt Mtn	1,020,978	100,635	103,297	4,723	46,693	1.214	0.056	0.549	0.437	0.020	0.198			
Tallahatta	777,774	79,970	80,860	3,386	35,855	1.248	0.052	0.553	0.449	0.019	0.199	8.98%	0.38%	3.98%

Table D-31. All Agricultural Land Irrigation Demand in Aquifer Production Zones as a Percentage of Total Recharge (Third Scenario)

ALL Ag Land														
AQUIFER	Production Area (ac)	Irrigated Acreage (ag)	MAX IRR Demand (acft)	MIN IRR Demand (acft)	AVG IRR Demand (acft)	MAX IRR Demand (in)	MIN IRR Demand (in)	AVG IRR Demand (in)	MAX IRR Demand 36% (in)	MIN IRR Demand 36% (in)	AVG IRR Demand 36% (in)	MAX % Recharge (@36%)	MIN % Recharge (@36%)	AVG % Recharg (@36%
Clayton	646,877	179,410	184,400	10,125	85,853	3.421	0.188	1.593	1.231	0.068	0.573	33.28%	1.83%	15.50%
Gordo	988,368	153,466	163,196	12,510	74,014	1.981	0.152	0.899	0.713	0.055	0.324			
Nanafalia aquifer	863,114	286,987	292,087	13,118	134,024	4.061	0.182	1.863	1.462	0.066	0.671	29.24%	1.31%	13.42%
Ripley Cusseta	730,536	146,452	154,544	9,299	68,717	2.539	0.153	1.129	0.914	0.055	0.406	35.15%	2.11%	15.63%
Salt Mtn	1,020,978	305,305	311,510	14,328	142,958	3.661	0.168	1.680	1.318	0.061	0.605			
Tallahatta	777,774	271,656	274,234	11,809	124,304	4.231	0.182	1.918	1.523	0.066	0.690	30.46%	1.31%	13.81%

4. Soil Conservation Measures Crop Model Results

Figure D-23 depicts the results from crop models increasing the organic carbon content of rainfed crop model experiments based on historic weather and soil data at the agricultural research station in Headland, Alabama. Additional organic carbon had a marginal impact on the rainfed results over the period (90 weather years:1921-2011).

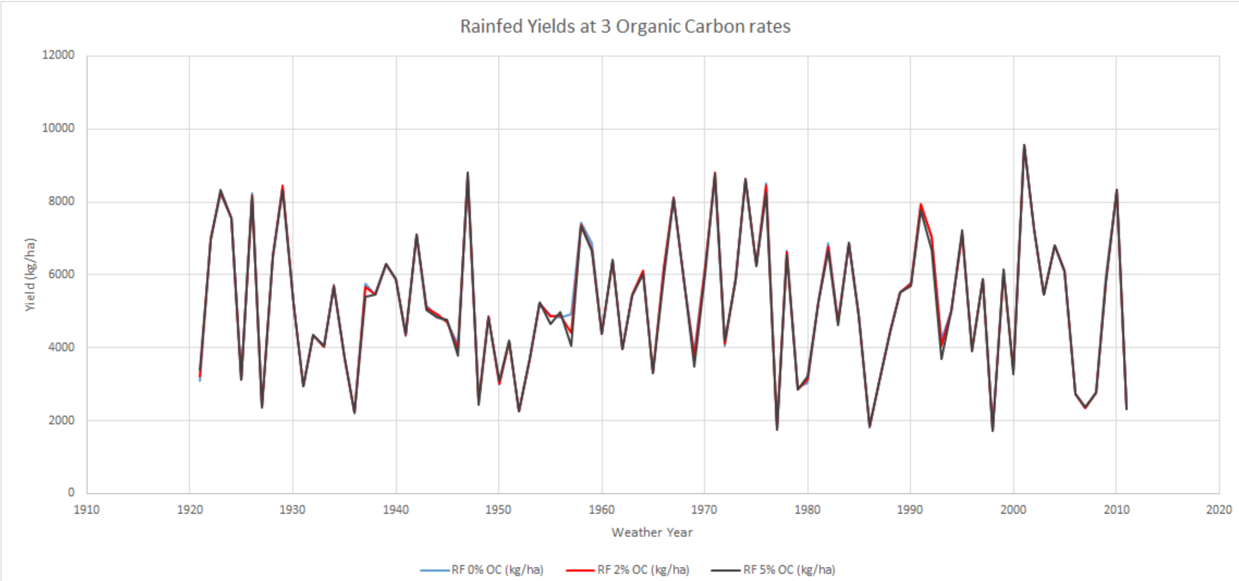

Figure D-23: Organic Carbon Content of Rainfed Yields Crop Model Results

Figure D-24 depicts the results from the model increasing the organic carbon content of rainfed crop versus an irrigated crop with no additional organic carbon. Even with a five percent increase in organic carbon, rainfed yields still do not compare with irrigated yields.

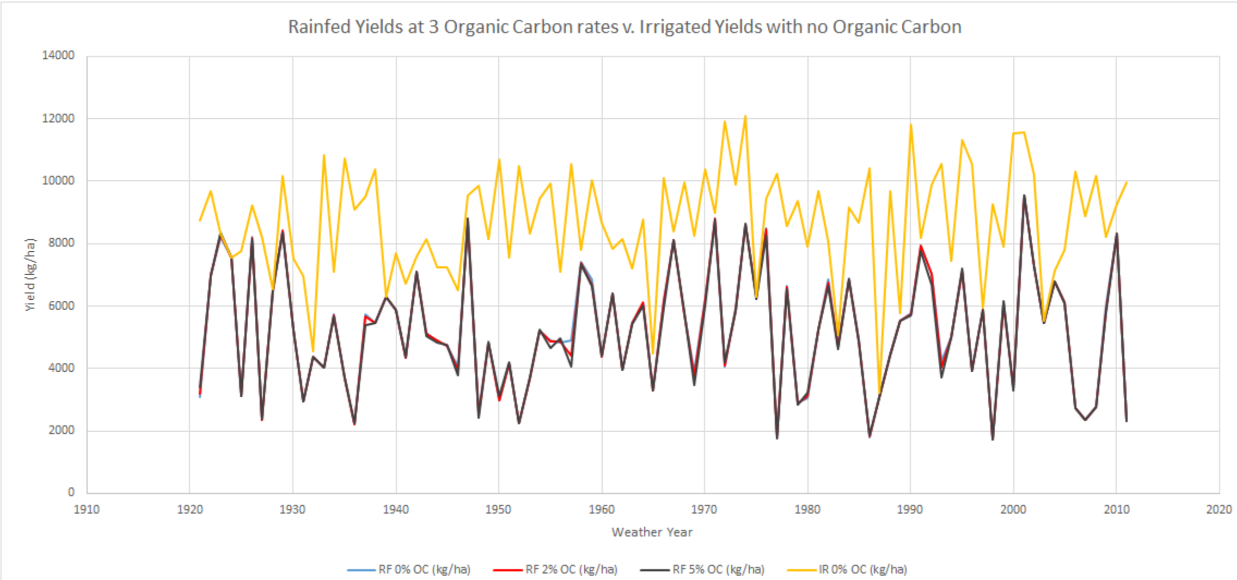

Figure D-24: Rainfed Crop Yields Compared to Irrigated Crop Yields

However, the combination of increased organic carbon and irrigation show a noticeable increase over irrigation alone (Figure D-25).

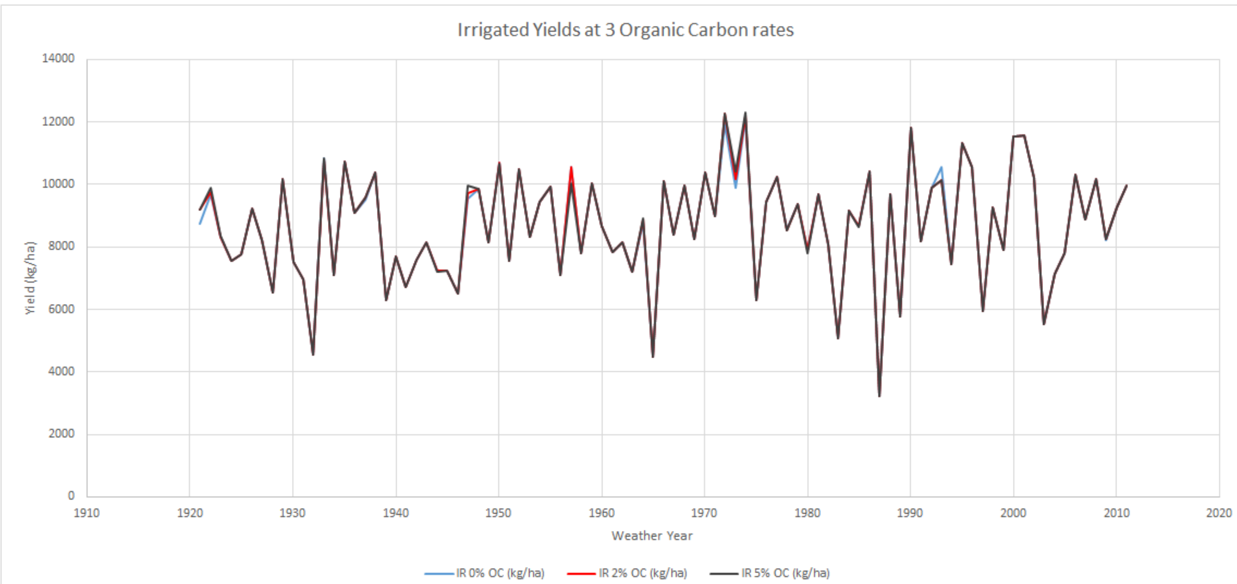

Figure D-25: Increased Organic Carbon and Irrigation Crop Yields

Yield statistics (in kg/ha) show similar increases when combining conservation measures and irrigation, as shown in Table D-32. In the table, OC refers to *"Organic Carbon as it relates to soil health*."

Table D-32. Crop Yield Statistics

	RF 0% OC (kg/ha)	RF 2% OC (kg/ha)	RF 5% OC (kg/ha)	IR 0% OC (kg/ha)	IR 2% OC (kg/ha)	IR 5% OC (kg/ha)
Average	5,243	5,228	5,196	8,681	8,694	8,695
MAX	9,558	9,561	9,553	12,095	12,276	12,304

5. Climate

5.1. Monthly Normals

The Livneh et al. (2014) climate dataset has an original horizontal resolution of 1/16 degrees which contains daily values of minimum temperature, maximum temperature, and precipitation for the period 1915-2011. This daily data was area weighted to the HUC-8 regions of the United States. An area-weighted daily average was then done for the combined area of the Upper and Lower Choctawhatchee and Pea Watersheds. This data was further averaged to monthly values for the 30-year period 1981-2010 which is the current period for climate normals in the United States. These average monthly temperature values are displayed in Figure D-26. The lowest minimum temperatures occur in December and January with values between 35 and 40 ^{o}F. The highest maximum temperatures occur in July and August with values near 90 ^{o}F. The average annual precipitation is about 57 inches with the maximum monthly value occurring in July of about 6.4 inches and the minimum monthly value occurring in October of about 3.3 inches (Figure D-27). The unexpectedly high averages shown in Figure D-27 for July and September are most likely caused by tropical systems or hurricanes.

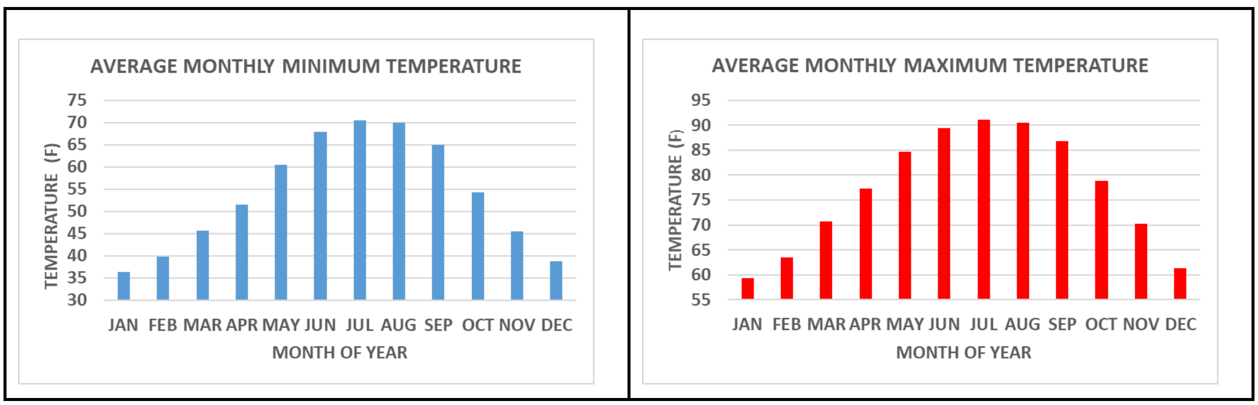

Figure D-26 Average Monthly Minimum Temperature (left) and Maximum Temperature (right) for the Choc-Pea Basin for the Period 1981-2010

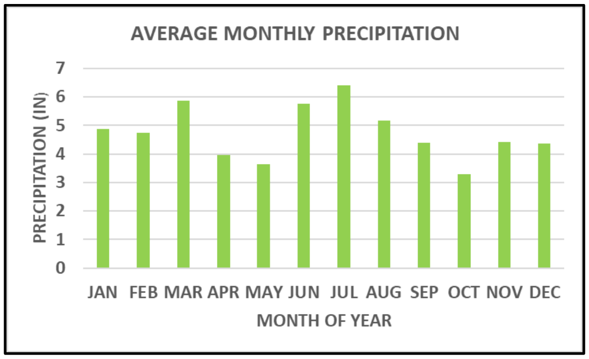

Figure D-27: Average Monthly Precipitation for the Choc-Pea Basin for the Period 1981-2010

5.2. Daily Precipitation

The daily precipitation data from 1981-2010 for the Choc-Pea Basin was sorted from smallest to largest and the cumulative distribution function was calculated then shown in Figure D-28. The period comprises 10,957 days which, when divided by 30 years, gives an average year length of 365.23 days, which is equivalent to 100 percent of the data. The vertical axis in Figure D-28 is labeled with respect to the "average day" rather than percentages. The 1-inch threshold is at about day 356 which leads to the conclusion that about 98 percent of the time daily precipitation amounts are 1 inch or less. The National Weather Service threshold for measurable precipitation at a given location is 0.01 inches. This threshold is at about day 152; so about 213 days of the year have values at or above this amount.

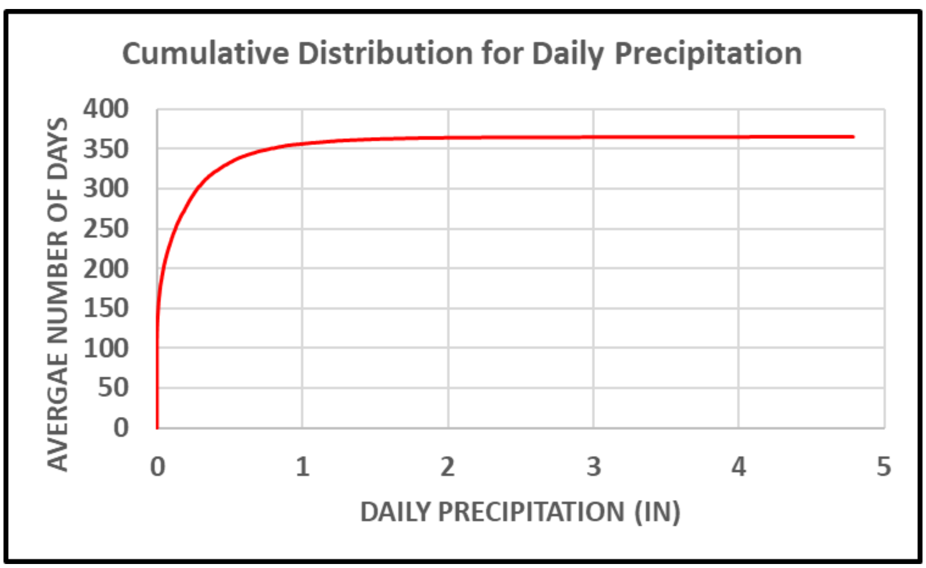

Figure D-28: Cumulative Distribution Function for Daily Precipitation Values for the Choc-Pea Basin for the Period 1981-2010

5.3 Precipitation Versus Evaporation

5.3.1. Monthly Averages

Monthly evapotranspiration on the HUC-8 scale is one of the outputs of the Water Supply Stress Index (WaSSI) hydrology model (Caldwell et al., 2012). The evapotranspiration calculations are detailed in Sun et al. (2011a, 2011b) and involve three steps. In the first step a monthly potential evapotranspiration is calculated by Hamon's method. The second step uses a set of multiple linear regression relationships which uses the Hamon values, precipitation, and leaf-area index to obtain evapotranspiration estimates for each land-use class. The final step limits the actual evapotranspiration to the available soil moisture. Figure D-29 shows the monthly averages for precipitation and the WaSSI-derived evapotranspiration for the Choc-Pea Basin for the period 1916-2011. Figure D-30 shows the monthly averaged precipitation minus the WaSSI-derived evapotranspiration for the same period (hereafter referred to as PME). The May-October period has PME values less than 1 inch with the exception of July.

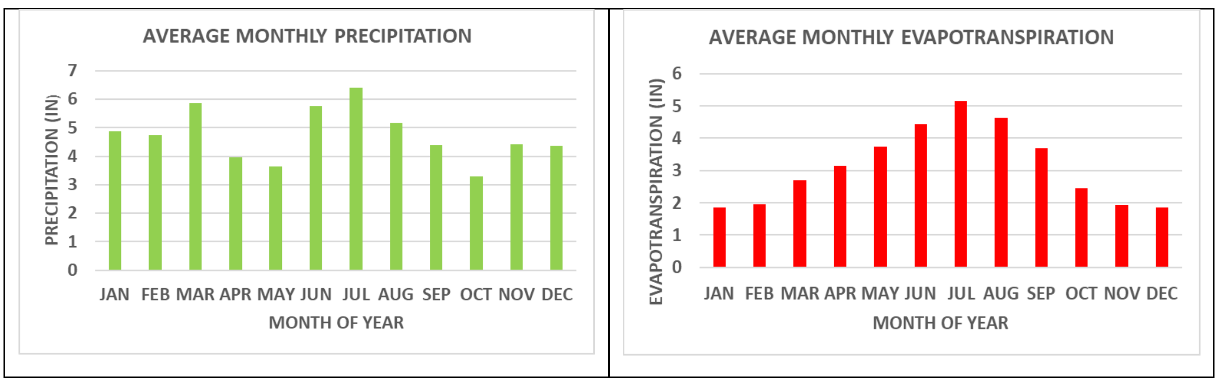

Figure D-29: Average Monthly Precipitation (left) and WaSSI-derived Evapotranspiration (right) for the Choc-Pea HUC-8 Basins for the Period 1916-2011

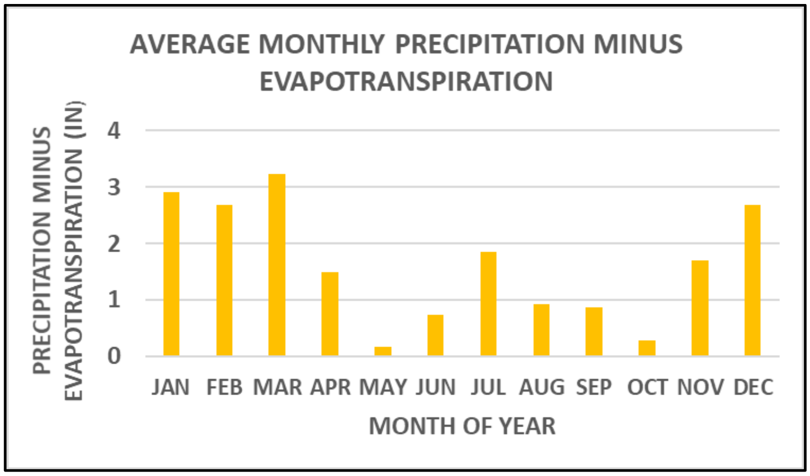

Figure D-30: Average Monthly Precipitation Minus WaSSI-derived Evapotranspiration for the Choc-Pea HUC-8 Basins for the Period 1916-2011

5.3.2. Return Periods

From standard hydrology practices "the return period of an event of a given magnitude may be defined as the average recurrence interval between events equaling or exceeding a specified magnitude" (Chow et al., 1988). In hydrology, this is typically related to flood events. Here it will be applied to the monthly PME values for the Choc-Pea Basin for the period 1916-2011. Three thresholds were chosen: 1) -12.5 mm (nominally 0.50 inches), 2) -25.0 mm (nominally 1.0 inch), and 3) -50.0 mm (nominally 2.0 inches). Six different time periods were also chosen from 1-6 months. For the monthly periods, time is in respect to consecutive months. Table D-33 gives the corres ponding return periods and Table D-34 provides the number of events. In Table D-33 for the -12.5 mm threshold and 1-month category, a return period of 0.48 years is displayed. That means that the return period for a PME of -12.5 mm **or less** and for a period of one month **or more** is 0.48 years. The shortest return periods are for the -12.5- and -25.0-mm thresholds for one month (0.48 and 0.81 years, respectively), and the -12.5 threshold for two months of 2.35 years. Larger departures in magnitude or length are less common having return periods of six years or more.

No events were found for five or six consecutive months. Only one event was found for four consecutive months at the -12.5 mm threshold and it was assigned a return period equal to the entire data record of 1916-2011. Tables D-35 and D-36 show the same information but are restricted to periods which overlap all or part of the growing season defined as April-September. There are fewer events because some dry periods occur earlier in the spring and later in the fall. Otherwise, the return period values are very similar.

Table D-33. Return Periods (years) for PME for the Choc-Pea HUC-8 Basins for the Period 1916-2011 for the Entire Calendar Year

Threshold	Time Periods (months)					
	1	2	3	4	5	6
-12.50 mm	0.48	2.35	10.18	95.97	NA	NA
-25.00 mm	0.81	6.61	31.93	NA	NA	NA
-50.00 mm	9.26	NA	NA	NA	NA	NA

Table D-34. Return Periods (years) for PME for the Choc-Pea HUC-8 Basins for the Period 1916-2011 for the Entire Calendar Year with the number of events

Threshold	Time Periods (months)					
	1	2	3	4	5	6
-12.50 mm	201	41	7	1	0	0
-25.00 mm	119	14	2	0	0	0
-50.00 mm	9	0	0	0	0	0

Table D-35. Return Periods (years) for PME for the Choc-Pea HUC-8 Basins for the Period 1916-2011 for the Growing Season (April – September)

Threshold	Time Periods (months)					
	1	2	3	4	5	6
-12.50 mm	0.25	1.03	5.34	95.97	NA	NA
-25.00 mm	0.45	3.43	NA	NA	NA	NA
-50.00 mm	8.26	NA	NA	NA	NA	NA

Table D-36. Return Periods (years) for PME for the Choc-Pea HUC-8 Basins for the Period 1916-2011 for the Growing Season (April – September) with the Number of Events

Threshold	Time Periods (months)					
	1	2	3	4	5	6
-12.50 mm	113	21	4	1	0	0
-25.00 mm	64	8	0	0	0	0
-50.00 mm	7	0	0	0	0	0

5.3.3. Probability of a Return Period

Another concept from hydrology is the probability of a return period (Chow et al., 1988). As used in hydrology with annual data, equation (1) gives the probability P of meeting or exceeding a specified event with a return period of T in N years. In the derivation of (1), it is assumed that the hydrological events from year to year are statistically independent. For our monthly PME values this is probably not true, but no effort has been applied to adjust for temporal correlation. When applied to the PME return values in Table D-33, P will be the probability of an event less than or equal to the given threshold and for the specified monthly duration. Since the source data is in months, both the return period T and the exponent N are in months. With these changes, when (1) is applied to the data in Table D-33, the results are shown as the curves in Figure D-31, where the N values are plotted as years.

(1) $$P = 1 - \left(1 - \frac{1}{T}\right)^N$$

Figure D-31 illustrates that PME values of either -12.5 or -25.0 mm for periods of one or two months are fairly common, with probabilities approaching 0.70 or more after three years. More extreme events require much more time to be likely, if at all.

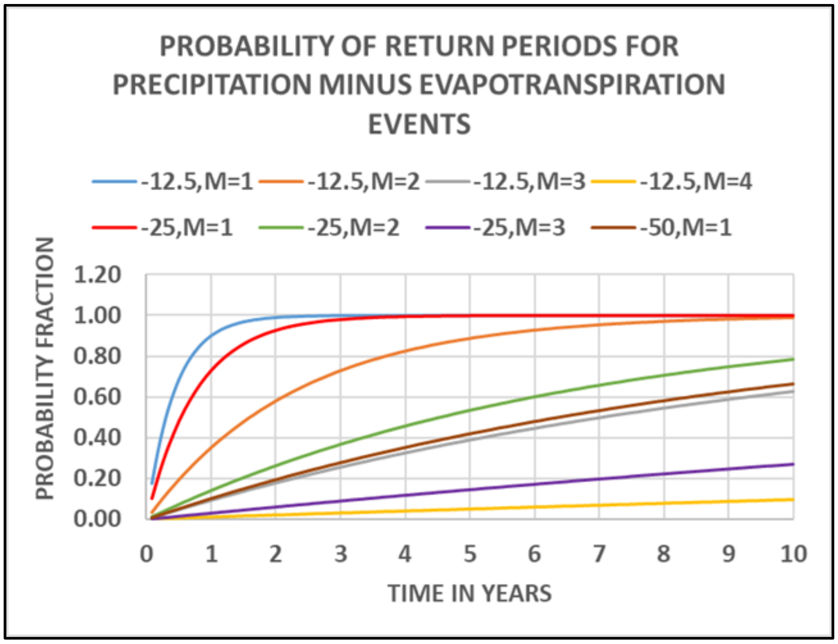

Figure D-31. Probability of a Return Period for PME Events for the Choc-Pea HUC-8 Basin for the Period 1916-2011 (see Table D-34)

6. Air Quality

6.1. Construction

In this discussion, the generation of particulate dust by construction activities related to installing the irrigation equipment will be assumed to be a good proxy for potential air quality impacts. Given the relatively small areas and time involved, it is assumed that the impacts would be negligible to minor and temporary. The philosophy below is to use the simplest tool possible but making assumptions to maximize concentrations where reasonable. The parameters used in this discussion are listed below in Table D-37.

Table D-37. Input Parameters for Dust Production Calculations

Description	Symbol	Value (units)
Weight of concrete mixer truck (empty)	W_T	30,000 (lbs)
Weight of concrete	W_C	40,000 (lbs)
Average farm size in Choc-Pea Basin	A	1.007 (km^2) (equal to 249 acres)
Radius of average farm size	R	0.566 (km)
Soil silt percentage	P	25.0 (%)
Concrete truck speed	G	0.011 ($km\ s^{-1}$) (equal to 25 mph)
Wind Speed	U	1.0 (meters per second)
2.5-micron fraction	k	0.15
10.0-micron fraction	k	1.0
emission equation silt exponent	a	0.90
emission equation weight exponent	b	0.45
Gaussian equation σ_Y dispersion parameter	c	24.167
Gaussian equation σ_Y dispersion parameter	d	2.5334
Gaussian equation σ_Z dispersion parameter	α	453.85
Gaussian equation σ_Z dispersion parameter	β	2.1166
Assumed concentration time	H	4 (hours)

To model dust production, this discussion assumes a concrete truck is the dust generator. This is reasonable given that such a vehicle is able to generate dust and it is possible that some farmers may need to have concrete pads poured for installation of the irrigation equipment. If pond construction is needed, it could potentially have more of an impact. The EPA document AP-42 (EPA 2019) states "Heavy construction is a source of dust emissions that may have substantial temporary impact on local air quality…" If needed, the same document describes wetting of soil or construction of wind barriers as mitigation measures. Due to the difficulty of estimating emissions for pond construction, the estimates of a concrete truck will be assumed to be a proxy for both irrigation equipment installation and pond construction.

The EPA document AP-42 (EPA, 2019) gives equation (1) as the formula for the emission rate on unpaved roads in units of g $vehicle^{-1}\ km^{-1}$, where k has a different value for different particle sizes, P is the soil silt percentage, and W is the weight of the vehicle. W is the total weight of the vehicle which is the sum of the W_T and W_C values in Table D-37. EPA has standards for two classes of particles: one is for particles with diameters less than or equal to 2.5 microns (μm), and the other is for particles with diameters less than or equal to 10.0 μm.

(1) $E = 281.9\, k \left(\frac{P}{12}\right)^{a} \left(\frac{W}{3}\right)^{b}$

Equation (2) gives the radius of the average farm area (A) in the Choc-Pea HUC. Accounting for the round trip, (D) is given by equation (3).

(2) $R = \sqrt{\frac{A}{\pi}}$

(3) $D = 2 * R$

Dividing the round-trip distance D by an assumed vehicle speed G gives an emission time T as in equation (4).

(4) $T = \frac{D}{G}$

Taking the emission value from equation (1) and multiplying by the distance D and dividing by the time scale T gives the emission rate (E_R) in units of g vehicle^{-1} s^{-1}, as given by equation (5).

(5) $E_R = \frac{E * D}{T}$

Equation (6) is a simple Gaussian plume model (EPA, 1995), where E_R is the emission rate from equation (5), K is a units conversion (10^6 gives a concentration of µg m^{-3} when E_R has the units of equation 5), V is a vertical distribution term, d is a decay term, π is the usual mathematical meaning, U is the wind speed, σ_Y is the lateral dispersion, σ_Z is the vertical dispersion, and Y is the distance from the plume center. Equation (6) gives an instantaneous, steady-state estimate of a concentration. Simplifying equation (6) to get an estimate of the maximum concentration (C_{MAX}), gives equation (7), where Y has been set to zero and the V and d terms are set to one.

(6) $C = \frac{(E_R\, K\, V\, d)}{(2\, \pi\, U\, \sigma_Y\; \sigma_Z)} exp \left[\frac{-1}{2}\left(\frac{Y}{\sigma_Y}\right)^2\right]$

(7) $C_{MAX} = \frac{(E_R\, K\,)}{(2\, \pi\, U\, \sigma_Y\; \sigma_Z)}$

A simple version of (6) and (7) uses the Pasquill-Gifford categories (Turner, 1970) to give estimates of the dispersion parameters as a function of stability, wind speed, and distance from the source. The Pasquill-Gifford categories are labeled as “A” through “F” as given in Table D-38, where “A” is the most unstable and “F” is the most stable. Given that the wind speed U has been set to a small value of 1 m s^{-1}, and that construction will likely occur in spring or summer daylight conditions, stability class “A” has been chosen from Table D-38. In equations (8) – (10), the parameters c, d, α, and β, in general, have different values for each stability class and for various distance ranges from the source (EPA, 1995). The values used in these calculations are listed in Table D-37.

$$(8) \quad \theta = 0.017\,[c - d \;\ ln\, ln\,(R)\,]$$

$$(9) \quad \sigma_Y = 465.12\, R\, tan\, tan\,(\theta)$$

$$(10) \quad \sigma_Z = \alpha\, R^{\beta}$$

Table D-38. Pasquill-Gifford Stability Classes (after Turner, 1970)

Wind Speed Category	Daytime Insolation Category			Nighttime Category	
10-m wind speed (m s^{-1})	strong	moderate	slight	cloud ≥ 4/8	cloud ≤ 3/8
< 2	A	A-B	B	E	F
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
> 6	C	D	D	D	D

With dispersion parameters specified by equations (8)-(10) and used in equation (7), the final 24-h maximum concentration estimate is given by equation (11). The time in hours for H is set at 4 h since concrete trucks would not be running continuously for this type of construction – it would likely be less than an hour given the amount of concrete to be delivered.

$$(11) \quad C_{MAX,24} = \frac{H}{24}\, C_{MAX}$$

The concentrations from the above approach are given in Table D-39 where they are compared against the current EPA standards for 2.5 μm and 10.0 μm particle size classes. It is observed that the modeled concentrations are well below the standards and, as previously mentioned, would likely be much smaller.

Table D-39. Comparison of Calculated and EPA Standard Particulate Concentrations

Particle Size Category	Estimates from Equation (11)	EPA 24-h standard
2.5 microns	4.3 μg m^{-3}	35 μg m^{-3}
10.0 microns	42.6 μg m^{-3}	150 μg m^{-3}

6.2. Fertilizer Application

Bouwman et al. (2002) summarizes the complex processes which control the NO_X ($NO + N_2O$) emissions from soils which, among many other factors, include soil temperature, moisture, texture, pH, fertilizer amount, and tillage practices. According to Bouwman et al. (2002), N_2O emissions tend to dominate the NO_X total for most soils. Accordingly, this section will focus on the increase of N_2O emissions resulting from the enhanced fertilizer applications which are usually done in conjunction with crop irrigation. Calculations will be done for the average farm size for the Choc-Pea Basin, and for rainfed and irrigated scenarios. Table D-40 lists the primary input parameters used in the N_2O emission calculations. The fertilizer application rates are obtained from simulations performed at UAH with the DSSAT crop model. The fertilizer is assumed to be ammonium nitrate (NH_4NO_3).

Table D-40. Input Parameters for N2O Calculations

Description	Symbol	Value (units)
Average farm size in Choc-Pea HUC	A	1.007 (km^2) (equal to 249 acres)
Wind Speed	U	1.0 (m s^{-1})
Rainfed Fertilizer Rate	F	202 kg ha^{-1} yr^{-1}
Irrigation Fertilizer Rate	F	280 kg ha^{-1} yr^{-1}

For these calculations, an area-source, two-dimensional, steady-state Gaussian model will be employed as in equation (12), where the concentration C is in units of μg m^{-3}. The symbols have the same meaning as in the particulate dust calculations (equation 6), except that E_R is now an area source with units of g m^{-2} s^{-1}.

$$(12)\quad C = \frac{E_R\ K}{2\ \pi\ U} \int \frac{V\ d}{\sigma_Y\ \ \sigma_Z} \left\langle \int \exp\left[\frac{-1}{2}\ \left(\frac{Y}{\sigma_Y}\right)^2\right] dy \right\rangle\ dx$$

The fertilizer rates in Table D-40 are for the total weight of fertilizer. To convert to a pure N rate F_{NR}, they are multiplied by a fraction as in (13), where 0.35 is the atomic weight of N divided by the molecular weight of NH_4NO_3.

$$(13)\quad F_{NR} = 0.35\ F$$

Millar et al. (2012) provides a relationship between nitrogen fertilizer application rate F_{NR} (kg N ha^{-1} yr^{-1}) and N_2O-N emissions (g N_2O-N ha^{-1} yr^{-1}), as in equation (14). To calculate the needed emission rate E_R used in (12), the appropriate units must be converted and scaled, as in equation (15). Factor number one (from the left) in (15) converts from ha^{-1} to km^{-2}. Factor number two converts from km^{-2} to m^{-2}. Factor number three converts from yr^{-1} to s^{-1}. For the last factor (number four), the emissions rate is scaled to an assumed growing season of four months out of twelve.

$$(14)\quad E = 670\, exp\ (\,0.0067\, F_{NR})$$

$$(15)\quad E_R = \frac{10^2}{1}\frac{10^{-6}}{1}\frac{1}{(365\ days*24\ hours*3600\ seconds)}\frac{12}{4}\ E$$

Using the values from (15) in (12) for both rainfed and irrigated scenarios gives the results in Table D-41 for the average farm size in the Choc-Pea HUCs, where the concentrations have been converted to Parts Per Billion (PPB) of N_2O. The increase in N_2O emissions is close to 3 PPB; however, both the rainfed and irrigated concentrations are well below the EPA 1-h N_2O standard of 100 PPB.

Table D-41. Impact of Increased Fertilizer Application with Irrigation

HUC Name	N_2O Rainfed (PPB)	N_2O Irrigated (PPB)	Difference (PPB)	EPA 1-h Standard (PPB)
Choc-Pea	17.1	20.5	3.4	100.00

6.3. Greenhouse Gas Emission Analysis

The COMET-Farm analysis system is designed to assess on-farm greenhouse gas emissions (USDA, 2020). COMET-Farm requires field definition, historic farm practices and future practices to evaluate both baseline and predicted greenhouse gas emissions. COMET-Farm is designed for field-scale evaluations and not regional emissions modeling. For this project, a representative 20-acre field located at the Wiregrass Research and Extension Service Farm was chosen. Conventional crop rotation, planting dates, fertilizer rates and irrigation applications were defined. For the baseline, no irrigation was applied. The results are included below in Figure D-32.

NAME: Cameron Handyside
PROJECT: Choc Pea WS Project 2
Daycent Status: Running at 100%
REPORTING YEARS: 2020 - 2029

JOBID: 15978_31075_143095
TIME: Thu Mar 26 2020 05:27:03 GMT-0500 (Central Daylight Time)
Version: Cloud deployment version 2.3.2, build 3.2.7390.16548 (26-Mar-2020)

USDA United States Department of Agricul
Natural Resources Conservation Ser

Source	Baseline Emissions		Irrigated			
	Emissions	+/-	Emissions	+/-	Change	+/-
Wiregrass (20 acres - Corn, Cotton, Soybean)						
C *(tonnes CO_2 equiv./yr.)*	-2.0	NR	-2.8	NR	-0.8	NR
CO_2 *(tonnes/yr.)*	0.0	+0/-0	0.0	+0/-0	0.0	+0/-0
CO *(tonnes CO_2 equiv./yr.)*	0.0	+0/-0	0.0	+0/-0	0.0	+0/-0
N_2O *(tonnes CO_2 equiv./yr.)*	24.8	NR	28.8	NR	+4.0	NR
CH_4 *(tonnes CO_2 equiv./yr.)*	0.0	+0/-0	0.0	+0/-0	0.0	+0/-0
Total	**22.8**	**NR**	**26.0**	**NR**	**+3.2**	**NR**

Figure D-32. Results of COMET Model for 20 acres of Corn, Cotton, and Soybeans at the Wiregrass Research and Extension Service Farm

Results show that irrigation increases yield which increases soil organic matter, including carbon capture, reducing C by 0.8 CO_2 metric tons equivalent per year. However, increased fertilizer application (NO_2) creates an increase of 4.0 CO_2 metric tons equivalent per year.

The COMET-Farm system also outputs the margin of error for different greenhouse gas components as shown in Figure D-33, below.

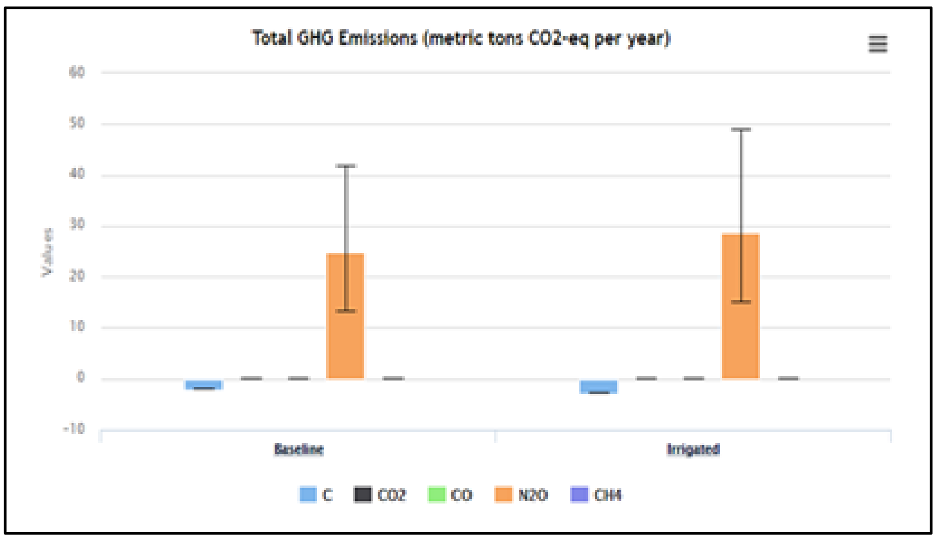

Figure D-33: Graph of Emission Components

The COMET-Farm system is designed to assess emissions due to farm management changes. However, the results can be compared to the air quality model used to determine NO_x emissions. Converting the COMET mass rate numbers to a concentration involves two steps and several assumptions, as shown below.

$$(1) \quad R_{N2O} = \frac{R_{CO2}}{1} \frac{10^3}{1} \frac{1}{298} \frac{12}{4} \frac{249}{20} \frac{1}{\Delta t}$$

The terms in equation (1) on the right-hand side will be discussed, from left to right. The first term, R_{CO2}, is the annual increase in metric tons of N_2O in CO_2 equivalent mass obtained from the COMET model (4.0). The second term, 10^3, converts metric tons to kg. The third term, 298^{-1}, converts CO_2 equivalent mass to actual N_2O mass in kg. The fifth term scales the 20-acre COMET plot to the average farm size of 249 acres. The fourth term, 12/4, takes the annual number and scales it to the four months of the growing season. The last term, Δt, is the number of seconds in a year. The result on the left-hand side, R_{N2O}, is the emission rate of N_2O in kg s^{-1}.

$$(2) \quad C_{N2O} = \frac{R_{N2O}\ \Delta t_E}{A\ Z} \frac{10^3}{1} \frac{10^6}{1} \frac{f}{1}$$

To convert the emissions rate from equation (1) to a concentration, several assumptions must be used. Equation (2) shows the variables needed to convert an emission rate to a concentration. The terms in equation (2) on the right-hand side will be discussed from left to right. The numerator in the first term multiplies an emission rate R_{N2O} times an emission time scale, Δt_E, which gives a mass value in units of kg. The denominator in the first term calculates a volume by multiplying a farm area (249 acres converted to m^2) times a planetary boundary layer (PBL) height Z. Typical spring and summer maximum values of Z are on the order of 1-2 km; a value of 1,000 m has been used here. The second term, 10^3, converts kg to g. The third term, 10^6, converts g to micro-grams (μg). With these three terms a concentration of μg m^{-3} is defined. The final factor "f" (a constant for standard pressure and temperature), converts μg m^{-3} to parts per billion (PPB), which is the unit of C_{N2O}. The emission time scale, Δt_E, could be defined by one of many different ways. Using the same wind speed as the Gaussian plume calculations (1 m s^{-1}) and the distance defined by a square of the farm size A, this gives a time scale of about 15 minutes for air to travel across the example farm. Another equally important time scale is the time required for an air parcel to climb to the top of the PBL and back to the surface. Assuming a circular eddy and same velocity gives a time scale of about 50 minutes. Since the latter is close to an hour, Δt_E has been set to 1 h (3,600 s). The R_{CO2} value of 4 metric tons per year when multiplied by the factor 249/20 (scaling the COMET results from 20 acres to 249 acres) gives a value of 49.8 metric tons per year. The value of 49.8 metric tons per year gives an increase of 0.10 PPB of N_2O, which is considerably smaller than the number of about 3 PPB obtained from the Gaussian plume calculations. This difference can be partly explained by the fact that the Gaussian plume calculations were done in a way to give the maximum possible, worst-case scenario value of concentration increase at the center of a down-wind plume, and do not give an area average estimate of the concentration across the field. Nonetheless, the conclusion is the same: the increase in N_2O concentration is below the EPA 1-h standard of 100 PPB. A summary of the key numbers in this calculation are given in Table D-42.

Table D-42. Summary of Key Variables in N_2O Concentration Calculation

R_{CO2} (metric tons/year)	A (m^2)	Z (m)	Δt_E (s)	C_{N2O} (PPB)
49.8	1.0×10^6	1,000	3,600	0.10

Appendix E

Other Supporting Information

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288
MOBILE, AL 36628-0001

March 7, 2011

FIELD LEVEL AGREEMENT BETWEEN
THE US ARMY CORPS OF ENGINEERS, MOBILE AND NASHVILLE DISTRICTS
AND
THE NATURAL RESOURCES CONSERVATION SERVICE
CONCERNING FARM POND EXEMPTIONS IN ALABAMA

I. Introduction:

On February 25, 2005, joint guidance between the Department of Agriculture, Natural Resources Conservation Service (NRCS) and the US Army Corps of Engineers (USACE) reaffirmed their commitment to ensuring that Federal wetlands programs are administered in a manner that minimizes the impacts on affected landowners consistent with the important goal of protecting wetlands. NRCS and USACE offices were encouraged to develop local partnerships to provide timely and accurate information to the public and to address other wetland issues.

In support of this joint guidance; NRCS, Alabama and USACE, Mobile and Nashville Districts have adopted a Field Level Agreement (FLA) pertaining to farm pond exemptions. The FLA establishes procedures for farmers to follow when requesting ponds on their property.

II. Terms:

A. Wetland Delineations depict the boundaries of waters of the US, such as wetlands and streams.

B. Verified Wetland Delineations depict the boundaries of waters of the US, such as wetlands and streams, and have been certified as accurate in writing from the NRCS or USACE for Food Security Act (FSA) or Clean Water Act (CWA) purposes, respectively.

C. Jurisdictional Determination by the NRCS or USACE identities the areas and/or activities subject to jurisdiction under provisions of the FSA or CWA, respectively.

D. Preliminary Jurisdictional Determination is a USACE document indicating that there may be waters of the United States on a parcel or indications of the approximate location(s) of waters of the United States on a parcel.

E. Approved Jurisdictional Determination is a USACE document stating the presence or absence of waters of the United States on a parcel or a written statement and map identifying the limits of waters of the United States on a parcel.

III. Procedures:

A. Jurisdictional Determinations

1. Jurisdictional Determinations performed by the NRCS must be verified by the USACE for purposes of the CWA.

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Figure E-1: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 1)

2. The NRCS will inform land owners that Jurisdictional Determinations verified by the NRCS are not valid for CWA purposes.

3. The USACE will inform land owners that Jurisdictional Determinations by the USACE may not be valid for FSA purposes. All USACE Jurisdictional Determinations will include the statement "This delineation/determination has been conducted to identify the limits of the US Army Corps of Engineers' Clean Water Act jurisdiction for the particular site identified in this request. This delineation /determination may not be valid for the wetland conservation provisions of the FSA of 1985, as amended. If the land owner is a US Department of Agriculture (USDA) program participant, or anticipates participation in USDA programs, he/she should request a certified wetland determination from the local office of the Natural Resources Conservation Service prior to starting work."

4. The NRCS will inform land owners that Jurisdictional Determinations by the NRCS may not be valid for CWA purposes. All NRCS Jurisdictional Determinations will include the statement "This delineation/determination has been conducted for the purpose of implementing the wetland conservation provisions of the FSA of 1985. This determination/delineation may not be valid for identifying the extent of the USACE CWA jurisdiction of this site. If the landowner intends to conduct any activity that constitutes a discharge of dredge or fill material into wetland or other waters, he/she shall request a jurisdictional determination from the local office of the USACE prior to starting work."

5. Approved Jurisdictional Determinations by the USACE for CWA purposes will remain valid for a period of 5 years unless new information warrants revision prior to that date.

B. Exemption Determinations

1. NRCS and USACE will follow procedures outlined in the "Alabama Farm Pond Exemption Guide" when providing assistance to land owners requesting technical assistance in construction of farm ponds or land owners requesting assistance with a determination as to whether a proposed farm pond is or is not regulated under the CWA.

2. NRCS will maintain a log in each field office for ponds that, based on information provided by the farmer, would most likely not be regulated under the CWA. The logs will identify the following information: landowner's name, address, pond size, purpose of the pond, county, and lat/long coordinates of the proposed pond. A copy of the logs will be forwarded to the NRCS State Conservation Engineer for submittal to the appropriate USACE District Office on a quarterly basis. An annual meeting to discuss past, present and future projects will also be scheduled.

3. Activities for the purpose of maintaining existing farm ponds, farm roads, center pivot crossings or irrigation ditches (returning it to a pre-existing condition) in waters of the United States **may or may not** be exempt from CWA jurisdiction. Review of these activities should be coordinated with USACE. Typically:

a. In order for center pivot crossing construction in wetlands/streams to be considered exempt and not regulated under the CWA, the project must meet the criteria outlined in Section 404(f) of the Clean Water Act and Section 323.4, Title 33 of the CFR. In addition, crossings shall not exceed 8-feet in width at the top, side slopes shall not exceed 3:1, and water crossings shall either be bridged or have culverts in place sufficiently sized to maintain normal surface water flows.

b. In order for irrigation ditch construction in wetlands/streams to be considered exempt and not regulated under the CWA, the project must meet the criteria outlined in Section 404(f) of the Clean Water Act and Section 323.4, Title 33 of the CFR. In addition, all excavated material shall be disposed of on

Figure E-2: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 2)

high ground if at all possible or placed alternately in piles on either side of the ditch to maintain normal surface water flows. Excavated material shall not be converted into a road unless that road could be separately exempted as a farm road.

c. In order for farm road construction in wetland/streams to be considered exempt and not regulated under the CWA, the project must meet the criteria outlined in Section 404(f) of the Clean Water Act and Section 323.4, Title 33 of the CFR. In addition, the land owner must demonstrate it is not possible to access the area from any other high ground (upland) access point even if that point is on other property. Road widths shall be the minimum necessary for the intended farm purpose. Road length shall be the minimum necessary to cross the wetland/stream (at the narrowest point of the wetland), land clearing (stump removal) shall be confined to the footprint of the road, and water crossings shall either be bridged or have culverts in place sufficiently sized to maintain normal surface water flows.

IV. General:

A. The policy and procedures contained in this FLA do not create any rights either substantive or procedural to a jurisdictional determination or a farm pond exemption determination by either agency or the United States.

B. This agreement will take effect ten (10) days after the date of the last signature below and will continue until modified or revoked by agreement of any of the parties or until revoked by any party alone upon written notice.

C. USACE Mobile and Nashville District and the NRCS in Alabama will review this FLA on an annual basis for the purpose of modification or extension. If this FLA is not modified or revoked it will automatically be extended.

William E. Puckett 3-23-11
William E. Puckett, PhD (date)
State Conservationist
NRCS

Craig J. Litteken 5/5/11
Craig J. Litteken (date)
Chief, Regulatory Division
Corps of Engineers, Mobile District

Ronald E. Gatlin 4-14-11
Ronald E. Gatlin (date)
Chief, Regulatory Branch
Corps of Engineers, Nashville District

Figure E-3: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 3)

ALABAMA FARM POND EXEMPTION GUIDE

A. Pond Construction: Pond size shall not exceed the need shown through a water budget. In waters of the US, the placement of fill material shall be limited to dam or berm construction. Land clearing (stump removal) shall be limited to the dam or berm, including auxiliary spillway entry and exit sections, and normal pool footprint. No fill shall be placed in wetlands to build up areas around the pond.

B. Producer Eligibility: To be eligible for the farm pond exemption, the land owner must be a producer who engages in either agriculture or livestock production. Land owners who **propose** new agricultural or livestock operations will be deferred to the USACE for an exemption determination. Proposed operations are those that do not have the required crops, existing irrigation equipment, or livestock at the time of the exemption request. The USACE will determine whether to exempt the pond from the Section 404 permit process. Agricultural and livestock production are defined below:

C. Agricultural production: Agricultural production is defined as a farm or ranch operation involving the production of crops including but not limited to:

- Field-grown ornamentals (not containerized)
- Flowers or bulbs
- Grains or row crops
- Hay, forage or pasture
- Naval stores
- Orchards or vineyards
- Seed Crops
- Plant materials
- Tobacco
- Trees
- Turf Farms
- Vegetables or fruits

Note: Trees will require case specific justification from the AL Forestry Commission and acceptance by the NRCS or USACE defining the need and quantity of irrigation water.

4

Figure E-4: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 4)

D. Livestock production: Livestock production is defined as a farm or ranch operation involving the production, growing, raising, or reproducing of livestock or livestock products, including but not limited to:

- Beef cattle
- Buffalo
- Dairy cattle
- Horses
- Ostriches or Emu
- Poultry
- Sheep or goats
- Swine
- Turkeys

E. Water Budgets: For a pond to supply a permanent water supply, it is necessary to provide sufficient water depth to meet the intended use taking into account seepage and evaporation losses. During severe drought conditions in Alabama, ponds can lose 4 ft. of water depth. For this reason, embankment ponds for irrigation and livestock purposes should always have at least 8 ft. of water at the deepest part of the pond. In Alabama, the maximum storage period is normally 180 days or 6 months (dry months of the year) for animals.

1. Estimated water needs for common crops in Alabama:

Ag. Production [1, 2]	Crop Water Needs (Ac-ft / acre of crop)
Row crops	1.5
Tobacco	1.0
Hay, Forage or Pasture	1.25
Vegetables[3]	1.25
Orchards	1.5

[1] *Documentation of water needs for crops not shown in this table shall be provided to NRCS.*

[2] *The land owner must have existing irrigation equipment. All new operations or operations without irrigation equipment shall be required to submit an exemption determination request to the USACE.*

[3] *Land owners that produce multiple crops during a year may include crop water needs for each crop when predicting water needs.*

5

Figure E-5: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 5)

2. Examples of situations where ponds meet crop water budgets:

Example 1: *A land owner irrigates 50 acres of cotton and would like to have a 20 acre irrigation pond. The proposed 20 acre pond site would have 16 ft. of water at the dam and a 15 acre surface at the 12 ft. depth (drought level).*

Crop Acreage	=	50 acres
Water needs	=	1.5 ac-ft/ac
Total water needs	=	75 ac-ft
Available water at 12 ft drought level 0.4 X 15 ac. X 12 ft.	=	72 acre-ft (defensible)
Pond total volume 0.4 X 20 ac. X 16 ft.		128 acre-ft

Example 2: *A land owner irrigates 100 acres of pasture. The land owner wants a 25 acre pond. The pond will need to have 20 ft. of water at the dam to produce a 25 acre pond. At the 16 ft. depth (drought level) the water surface would cover 19 acres.*

Pasture Acreage	=	100 acres
Water needs	=	1.25 ac-ft/ac
Total water needs	=	125 ac-ft
Available water at 16 ft drought level 0.4 X 19 ac. X 16 ft.	=	121.6 acre-ft (defensible*)

3. Estimated livestock water requirements in Alabama:

Livestock Production [1]	*Drinking Water Needs (gallons/day/hd)*
Dairy cattle	25
Beef cattle	12
Sheep or Goats	1.5
Horses	12

[1] *Other livestock may be used with proper documentation to NRCS to predict water needs.*

6

Figure E-6: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 6)

4. **Examples of situations where ponds meet livestock water budgets:**

Example 1: *A land owner with a 50-head beef cattle operation has requested a pond exemption. An excavated pond site is not feasible. An embankment pond site with 8 ft. of water at the dam would have 0.6 acre of surface area. At a 4 ft. depth (drought level) the water surface would be 0.25 acres.*

50hd @ 12 g/day/hd	=	600 gal/day
Maximum storage period	=	180 days
1 acre-ft	=	325,851 gal
Therefore, cattle water needs	=	0.331 acre-ft
Available water at 4 ft drought level 0.4 X 0.25 ac. X 4 ft.	=	0.40 acre-ft (defensible*)
Pond total volume 0.4 X 0.6 ac. X 8 ft.	=	1.92 acre-ft

*Even though the available water at the drought level is more than the cattle needs for the storage period, the site is still defensible since there is only 8 ft. of water at the dam.

Example 2: *A land owner with a 300-head beef cattle operation has requested a pond exemption. The land owner wants a 1 acre pond. The pond will need to have 12 ft. of water at the dam to produce a 1 acre pond. At the 8 ft. depth (drought level) the water surface would cover 0.6 acres*

300 hd @ 12 g/day/hd	=	3,600 gal/day
Maximum storage period	=	180 days
1 acre-ft	=	325,851 gal
Therefore, cattle water needs	=	2 acre-ft
Available water at 8 ft drought level 0.4 X 0.6 ac. X 8 ft.	=	1.9 acre-ft (defensible)

7

Figure E-7: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 7)

F. Farm Pond Exemption application procedures for land owners by pond category:

1. For ponds being used for the irrigation of crops or the watering of livestock that have a normal pool area less than 10 acres, the following information shall be submitted to the NRCS:

   a. Farm Pond Exemption Information Paper (Exhibit 1) completed and signed by the land owner.
   b. Water budget.
   c. Completed Form AD-1026A from FSA.
   d. Site map with pond coordinates, i.e. USGS topographic, county, DOT map or other map source as appropriate.

2. For ponds being used for the irrigation of crops or the watering of livestock that have a normal pool area **greater** than 10 acres, the land owner shall provide the information on the attached "USACE Checklist for Farm Pond Exemption Determination" (Exhibit 2) to the USACE.

3. For ponds whose purpose is not providing water for the irrigation of crops or the watering of livestock, the land owner shall contact the USACE to discuss project feasibility and requirements for authorization.

4. For ponds that require a pump station and/or access road to facilitate water supply, the land owner shall provide the information on the "USACE Checklist for Farm Pond Exemption Determination".

5. For work on existing farm ponds the following information is required;

   a. If the proposed work will not cause the cumulative acreage of the pond to exceed 10 acres, the land owner shall provide the following information to the NRCS:

      1. Farm Pond Exemption Information Paper (Exhibit 1) completed and signed by the land owner.
      2. Water budget.
      3. Completed Form AD-1026A from FSA.
      4. Site map with pond coordinates, i.e. USGS topographic map, county, DOT map or other map source as appropriate.

   b. If the proposed work causes the cumulative acreage of the pond to exceed 10 acres, the land owner shall provide the information on the attached "USACE Checklist for Farm Pond Exemption Determination" (Exhibit 2) to the USACE.

   c. If the proposed work does not cause an increase in the cumulative acreage of the pond, such as maintenance or a decrease in pond size, no authorization will be required from the USACE. Work under this category is subject to oversight and approval by the NRCS.

8

Figure E-8: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 8)

Definitions:

Drought Level – During a severe drought in Alabama, ponds can lose 4 ft. of water. The drought level for a pond is therefore assumed to be 4 ft. below the normal pool elevation. Storage at the drought level is considered available water for irrigation or livestock purposes.

Field Level Agreement (FLA) – Governing agreement between the USACE and NRCS concerning jurisdictional determinations and farm pond exemptions.

Farm Pond – For the purpose of the FLA, a farm pond is defined as an impounded water source created by constructing an embankment or excavating a pit that is intended to provide water for the irrigation of crops or livestock operations.

Farm Pond Exemption – Frees a land owner from the requirement of obtaining a Section 404 Clean Water Act permit through the USACE for construction of a farm pond (33 CFR 323.4).

Water Budget – A water budget establishes a baseline of water quantity required to sustain the normal livestock or irrigation operation. Crop water requirements or livestock requirements will be based on the land owner's records, but will be close to published requirements. To be eligible for the farm pond exemption, a water budget will be developed for all requests. The water budget will define the pond storage requirements in acre-feet at the pond drought level.

Exemption Information Paper – A document provided by NRCS to land owners requesting a farm pond exemption that identifies the operation size, water requirements and site information.

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Figure E-9: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 9)

Exhibit 1.

FARM POND EXEMPTION INFORMATION PAPER

LAND OWNER PRODUCER INFORMATION			
Name:			
Mailing Address:			
City, State, Zip Code:		County:	

POND INFORMATION [1/]				
Primary Purpose: (Ag, Livestock, Recreation, etc.)		Location:	LAT	LON
Size at Normal Pool (acres):		Estimated Storage at normal pool (Ac-ft):		

[1/] *Non-Farm Ponds and ponds having a normal pool size larger than 10 acres must be directed to the USACE.*

AGRICULTURE OR LIVESTOCK PRODUCTION INFORMATION [2/, 3/]					
Crop Type:		Cropped Acreage (ac.):		Crop Water Needs (ac-ft)	
Livestock Type:		Herd Size (hd):		Livestock Water Needs (ac-ft)	
				Additional Water Needs (ac-ft)	
				Total Farm Water Needs (ac-ft)	

[2/] *A water budget must be attached to this document justifying the above values.*

[3/] *Land owners requesting exemption by crop water needs but do not currently irrigate their crops must be directed to the USACE for exemption.*

Land Owner Certification: I certify that the above information is accurate to the best of my knowledge. I understand that this exemption does **NOT** free me from obtaining any other federal, state or local permits for construction of the proposed pond. I understand that if any revisions are made to the project or its intended use, this exemption determination may be invalidated. Should it be determined that the pond has been converted to a non-agricultural use at any point, I may be required to obtain a Department of the Army permit in order to maintain the pond. Any Department of the Army permit application must include an alternatives analysis and mitigation and should a permit not be issued, restoration of the site may be required. A pond exempt from the need for a Department of the Army permit is not exempt from regulations required by the State of Alabama.

(Type or print name) *(Signature)* *(Date)*

NRCS Certification: I certify that this land owner has been advised of the requirements as outlined in the NRCS Farm Pond Exemption Guide and in the Field Level Agreement between USACE and NRCS. Sufficient documentation has been provided that defends the need and size of the proposed pond.

(Type or print name) *(Signature)* *(Date)*

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Figure E-10: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 10)

Exhibit 2.

CHECKLIST FOR USACE FARM POND EXEMPTION DETERMINATION FOR PONDS OVER 10 ACRES IN ALABAMA

1. ___ Land owner's full name, mailing address and day time telephone number. Also include the name of a contact person if owner is a company or other organization.

2. ___ If the land owner is not the farmer, the farmer's full name, mailing address, day time telephone number and relationship with the owner. Also include the name of a contact person if owner is a company or other organization.

3. ___ The latitude/longitude coordinates for the pond location in decimal degrees.

4. ___ A water budget demonstrating the land owners need to provide water for livestock operations or irrigation of crops including the size pond needed.

5. ___ Vicinity and location maps showing the proposed pond site. Excerpts of US Geological Survey topographical quadrangle maps, county road maps, or other similar maps may be used. Vicinity maps should be of an appropriate scale to locate the site by nearby landmarks.

6. ___ A completed and signed NRCS "Farm Pond Exemption Information Paper" (Exhibit 1) form.

7. ___ A written statement documenting all other water sources and stating why those sources are inadequate.

8. For an irrigation pond:

   a. ___ An aerial photograph identifying areas to be irrigated with acreages.

   b. ___ The method/s of irrigation to be used - center pivot, etc.

Note: All information must be on 8 1/2 " X 11" paper and must be legible and reproducible. The use of color in exhibits is not acceptable because color does not reproduce in black and white. Color infra-red aerial photographs are the only exception.

Mail to:

USACE, Mobile District Attn: RD, Regulatory Division 109 Saint Joseph Street Mobile, AL 36602	Or	USACE, Nashville District Attn: RD, Regulatory Branch 3701 Bell Road Nashville, TN 37214

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Figure E-11: NRCS & ACOE Agreement Concerning Farm Pond Exemptions (Page 11)

The following figure represents the ALFA distributed Survey used as part of the Project Scoping Process:

Agricultural irrigation is poised for expansion in Alabama. In order to better understand farmers' interest in expanding rrigation in the state, your input is needed. If you currently irrigate, or if you would like to add irrigation on your farm, lease complete the information below. All information provided will remain confidential.

In order to help us collect the best possible information, please note:

- The first section of the survey should only be completed by those currently irrigating crops.
- The second section should only be completed by those who do not currently irrigate.
- The third section should be completed by all respondents.

The survey can also be completed online at www.alabamairrigation.org.

Thank you for taking time to assist with this survey!

Only Answer Questions 1 – 10 if you are currently using irrigation

1. Do you currently irrigate crops in Alabama? If your answer is no, please skip to the next section of the survey.

____Yes ____No

2. In what county, or counties, in Alabama do you currently irrigate agricultural crops?

3. How many acres do you currently irrigate?

____ Less than 1 acre to 24 acres **____ 500 – 749 acres**

____ 24 – 49 acres **____ 750 – 999 acres**

____ 50 – 99 acres **____ 1,000 – 1,499 acres**

____ 100 – 249 acres **____ 1,500 – 1,999 acres**

____ 250 – 499 acres **____ 2,000 or more acres**

4. If a federally-funded cost share program was available, would you be more likely to invest in expanding your irrigated acres?

____Yes ____No

5. How many additional acres would you like to be able to irrigate if you qualified for cost-share funding?

____ Not interested in expansion at this time

____ Less than 1 acre to 24 acres **____ 500 – 749 acres**

____ 24 – 49 acres **____ 750 – 999 acres**

____ 50 – 99 acres	**____ 1,000 – 1,499 acres**
____ 100 – 249 acres	**____ 1,500 – 1,999 acres**
____ 250 – 499 acres	**____ 2,000 or more acres**

6. Do you currently have plans to irrigate any newly rented or leased acres?

____Yes ____No

7. If so, do you currently have rental/lease agreement for at least a minimum of five years?

____Yes ____No

8. What percentage of your cropland do you currently irrigate?

____ Less than 20%
____ 21 – 49%
____ 50 – 74%
____ 75 – 100%

9. What is your water source (check all that apply)?

____ Surface Water
____ On-farm pond or reservoir
____ Groundwater (well)

10. If you answered "surface water" above, please list the name of the river or stream.

____

Only Answer Questions 11 – 18 if you are currently NOT using irrigation

11. Do you currently irrigate crops in Alabama? If your answer is yes, please go back and complete the previous section of the survey. If your answer is no, please continue with the questions below.

____Yes ____No

12. In what county, or counties, in Alabama do you currently farm?

13. If a federally-funded cost share program was available, would you be more likely to invest in irrigation?

____Yes ____No

14. How many additional acres would you like to be able to irrigate if you qualified for cost-share funding?

____ Not interested in expansion at this time

____ Less than 1 acre to 24 acres
____ 24 – 49 acres
____ 50 – 99 acres
____ 100 – 249 acres
____ 250 – 499 acres
____ 500 – 749 acres
____ 750 – 999 acres
____ 1,000 – 1,499 acres
____ 1,500 – 1,999 acres
____ 2,000 or more acres

15. Do you currently have plans to irrigate any newly rented or leased acres?
____Yes ____No

16. If so, do you currently have rental/lease agreement for at least a minimum of five years?
____Yes ____No

17. What would be your water source (check all that apply)?
____ Surface Water
____ On-farm pond or reservoir
____ Groundwater (well)

18. If you answered "surface water" above, please list the name of the river or stream.

____

All respondents should complete the section below (questions 19 - 24)

19. Name: ____

20. Recent economic analysis concludes that installing a system irrigating 140 acres costs between $200,000 and $224,000, with a full return on investment within three to five years. This program will include a farmer cost share component. What cost-share percentage would you be willing to pay for irrigation?
____ None, I would not be willing to invest in irrigation even if cost-share funding was available
____ 25%, I would be willing to invest up to 25% of the total cost
____ 50%, I would be willing to invest up to 50% of the total cost
____ 75%, I would be willing to invest up to 75% of the total cost
____ 100%, I plan to expand irrigation on my farm with or without possible cost share funding

21. What types of conservation practices would you be interested in adding (check all that apply)?
____ Irrigation Pivot ____ Well
____ Irrigation Pipeline ____ Pump (electric)
____ Subsurface Irrigation ____ Pump (diesel)
____ Irrigation reservoir ____ Convert combustion pump to electric
____ Micro-irrigation
____ Convert current irrigation to low-pressure drop nozzles

22. Are there other irrigation practices not listed above you would be interested in?

____

23. Please enter the Latitude and Longitude of each location (field, hoop house, etc.) where irrigation would occur. To get the Latitude and Longitude for each location use the Compass App on your smartphone. Stand at the location to be irrigated and turn on your compass. The Latitude and Longitude will appear on your phone screen.
Lat: ______________________ Long:________________________
Lat: ______________________ Long:________________________

Lat: ________________________ Long:__________________________
Lat: ________________________ Long:__________________________
Lat: ________________________ Long:__________________________
Lat: ________________________ Long:__________________________

24. What has prevented you from irrigating or expanding irrigation on your farm?
____ Economics
____ Age
____ Access to Water
____ Land is rented
Other: ______________________________________

Please mail completed surveys to the following address:
Alabama Association of Conservation Districts
Attn. Katy Parker, Executive Director
P.O. Box 304800
Montgomery, AL 36130-4800
If you prefer to scan and e-mail, please send to katy@ALConservationDistricts.org
THANK YOU!

Figure E-12: ALFA Farmer Survey

ALABAMA IRRIGATION INITIATIVE
CHOCTAWHATCHEE-PEA WATERSHED

Johnny Hughes Community Center
December 18, 2018

Name	Phone	E-Mail
Jered Mather	334-796-6320	jeredmathis@gmail.com
Chris Mead	334-378-9245	chris.mead@al.usda.gov
Bill GODWIN	343-5192	billgodwin 5192@ Gmail
Richard Collier	334-566-7300x4	richard.collier@al.usda.gov
J.O. Norris	334 242 2662	jon.norris@swcc.alabama.gov
Brad Kimbro	334-701-8747	bKimbro@wiregrass.coop
Brandon McCraly	334-887-4534	Brandon.mccraly@al.usda.gov
Glenda Yohn	334-793-2310	Houston Co. SWCD
Johnny Lee	334-726-7222	State Comm.
ADAM SAWYERS		DC-DALE+HENRY Co
Marissa Chancy	334-684-2235	DAC geneva co. SWCD
Alex Vaughan	"	DC- geneva/huston co
Colleen Lewis	"	Geneva Co. District tech.
Rachel Kuntz		rmk0016@auburn.edu
Cameron Handyside	256 656 1578	cameron.handyside@aamu.edu
DOUG PARRISH	256 599 1474	DOUGPARRISH@TRIGREEN.COM
Winton Fulford	334-300-6342	wintonfulford@hotmail.com

Figure E-13: Sign-In Sheet for the December 18, 2018 Farmer Interest Meeting in Hartford, AL (Page 1)

ALABAMA IRRIGATION INITIATIVE
CHOCTAWHATCHEE-PEA WATERSHED

Johnny Hughes Community Center
December 18, 2018

Name	Phone	E-Mail
Brandon Dillard	(334) 726-3904	dillaba@auburn.edu
William Birdsong	(334) 723-6259	birdswc@auburn.edu
Ronnie Hale	(334) 534-2046	halesRonnie@yahoo.com
JASON Greene	334 672 1497	JASON Greene1386@yAHoo.com
Miles Robinson	334-552-1275	mrobinson2@tuskegee.edu
Barrett Vaughan	(334) 552-1152	bvaughan@tuskegee.edu
Kris Balkcom	(334) 726-7021	balkckb@auburn.edu
Randall Baker	(334) 805-9197	
Thomas Turner	334 726-5276	tarn1547@gmail.com
CoastPump	850-699-8024	aspiva[illegible]@cox.net
Coast Pump	850-699-8034	Jason Musgrove

Figure E-14: Sign-In Sheet for the December 18, 2018 Farmer Interest Meeting in Hartford, AL (Page 2)

ALABAMA IRRIGATION INITIATIVE
CHOCTAWHATCHEE-PEA WATERSHED

Johnny Hughes Community Center
December 18, 2018

Name	Phone	E-Mail
Clint Patterson	334 447 2035	C09Farms@yahoo.com
David Adams	334-367-6665	
Cindy Pate	334-262-7715	Cindy.Pate@mail.house.gov
SID CAMERON	229-938-0980	sid.cameron@valmont.com
Dorris Skipper	334-894-5581x3	coffee@alconservationdistricts.org
Allen Barrentine	334-726-0146	allen.wiregrassgin@gmail.com
Chad Barrentine	334-796-7793	chadbarrentine86@yahoo.com
Garrett Skinner	334-360-0061	garrettskinner0061@gmail.com
Joey Otts	301-3939	oferrill@aol.com
[illegible]	685-1398	cs131521@gmail.com
Steve Ingram	657-5876	
James Manasco	256-613-2609	james.manasco@mail.house.gov
Donnie Ward	334-726-2325	drward15@hughes.net
Shawn Carpenter	334 714-1622	Carpenter5farms@Yahoo.com
Bobby Edmondson	334 726 3278	bobbyedmondson46@yahoo.com

Figure E-15: Sign-In Sheet for the December 18, 2018 Farmer Interest Meeting in Hartford, AL (Page 3)

ALABAMA IRRIGATION INITIATIVE
CHOCTAWHATCHEE-PEA WATERSHED

Johnny Hughes Community Center
December 18, 2018

Name	Phone	E-Mail
Josh Elliott	894-5581	[illegible]
Logan Shirah	334-432-0922	Lshirah2014@icloud.com
Justin Cooper	334-621-0581	Justin@HiltonCooper.com
Kendall Cooper	334-703-0978	Kendall@HiltonCooper.com
TERRY Adams	334-618-3347	
STEVE BRANNON	334-449-0014	
Clay Wise	334-447-2267	Wise farm 285@gmail.com
Walt Walden	334-726-1203	
Jim Lewey	4475195	jim.lewey@yahoo.com
Max Bozeman	334-301-7025	
Scotty Farmer		
Brian Hardin	334-613-4217	[illegible]
Johnny Reynolds	912-383-5827	jrey6563@gmail
Robert [illegible]	334-313-7866	
Josh Dubree	334-403-0429	
Andy Sumblin	334-303-0030	andy@sumblinfarms.com
Todd Brannon	334-449-0059	toddbrannon69gtx@gmail

Figure E-16: Sign-In Sheet for the December 18, 2018 Farmer Interest Meeting in Hartford, AL (Page 4)

ALABAMA IRRIGATION INITIATIVE
CHOCTAWHATCHEE-PEA WATERSHED

Johnny Hughes Community Center
December 18, 2018

Name	Phone	E-Mail
Eve Brantley	334-740-4425	brantley@auburn.edu
Brenda Ortiz	334 703 6412	bortiz@auburn.edu
John Curtis	334-316-1008	John.Curtis@al.usda.gov
Bob Helms	334-406-7040	m2lhf@roadrunner.com
DONALD DAVIS	334-347-1738	DDAVIS@FIRSTSOUTHLAND.COM
Steve Dunn	334-248-2945	
Chuck Bright	334-726-1733	horace.bright@yahoo.com
Danny B McNeil	334 791 2956	danny.mcneil59@yahoo.com
Kevin Ward	334-657-2971	wardpeanuts@AOL.com
Caleb Bristow	334-618-9388	calebbristow613@gmail.com
Bobby Crutchfield	334-726-2273	bobbycrutchfield6@gmail.com
Jim Waite	334-208-3652	jimrwaite@gmail.com
Troy Fillingim	334-470-3094	fillingimcropins@hotmail.com
swcd Cindi Fain	334-606-3188	cwfain@hotmail.com

Figure E-17: Sign-In Sheet for the December 18, 2018 Farmer Interest Meeting in Hartford, AL (Page 5)

ALABAMA SOIL & WATER CONSERVATION COMMITTEE

ALABAMA ASSOCIATION OF CONSERVATION DISTRICTS

Alabama Irrigation Initiative
Farmers Irrigation Forum
Agenda

DATE & TIME: December 18, 2018, 9:30 am-11:30 am
LOCATION: Johnny Hughes Community Center, 405 S 3rd Avenue, Hartford, AL 36344

Coffee and Donuts provided by Reinke Manufacturing

9:30 AM	**Welcome and Introductions**	Johnny Lee, 1st Vice President Board of Directors, Alabama Association of Conservation Districts Senator Donnie Chesteen, Alabama Senate Cindy Pate, Field Representative, Office of US Representative Martha Roby James Manasco, District Field Representative, Office of Congressman Robert B. Aderholt
9:45 AM	**Irrigation Program Overview**	Dr. Bill Puckett, Executive Director, Alabama Soil and Water Conservation Committee
10:00 AM	**Farmer Discussion and Input**	Sabra Sutton, Executive Director, Alabama Association of Conservation Districts
11:10 AM	**Summary and Next Steps**	Dr. Bill Puckett, Executive Director, Alabama Soil and Water Conservation Committee
11:30 AM	**Lunch**	Provided by: Tri-Green

Project Partners:

Alabama Agricultural Experiment Station
Alabama Association of Conservation Districts
Alabama Cooperative Extension Service
ALFA
Alabama Soil and Water Conservation Committee
Auburn University
Auburn University Water Resources Center
University of Alabama-Huntsville
USDA-Natural Resources Conservation Service

Figure E-18: Agenda for Farmer Interest Meeting on December 18, 2018

Irrigation Meeting August 20, 2019

Enterprise Farmer's Market- Coffee County

Name	Your City, State	Email	Affiliation
1. Micah Garrett	Banks, AL	mgarrett@firstsouthland.com	lender/sponsor
2. Lee Childers	Ozark AL	lchilders@firstsouthland.com	lender/sponsor
3. Johnny Mack Hollis	Newton, AL.	jhollis@centurytel.net	Farmer
4. Cindy Kinney	Enterprise AL	ckinney@firstsouthland.com	Sponsor
5. JOHN HOLLIS	Newton, AL	John.Hollis@agspray.com	
6. Michael McCraney	Ozark, AL	mmccraney@firstsouthland.com	
7. Marshall Childers	Ozark, AL	mchilders@firstsouthland.com	Lender
8. Logan Shirah	BlueSprings, AL	lshirah@[illegible]	Farmer
9. Keith [illegible]	Bluesprings, AL	Shirah140@gmail.com	Farm
10. [illegible] Reynolds	Kinston AL	Jrey6963@Gmail	Farm
11. [illegible] W. Stephens	[illegible] AL	334 606 9577	Farmer
12. J. ALLEN WISE	SAMSON, AL	awise@sunsouth.com	Farmer
13. Clint Patterson	Kinston AL	cogfarms@yahoo	Farmer
14. ROGER W. MANGHAM	BRAM, AL	RMANGHAM@TNC.ORG	BIOLOGIST
15. Ronnie Hales	Hartford AL	halesronnie@[illegible]	
16. Hunter McBrayer	Montgomery, AL	hmcbrayer@alfafarmers.org	/ALFA
17. Jim Lewey	Samson, AL		Farm
18. Michael Mills	Harrisburg, NC	Mikemills@reinke.com	Reinke
19. C W Hartzog	Slocomb Al		Farm
20. Todd Hicks	Dothan, Al	stoddhicks@yahoo.com	observing/learning
21. Josh Carnley	Kinston, AL	jcarnley79@gmail.com	Farmer/CPYRWA [illegible]
22. Todd Brannon	Hartford, Al	toddbrannon[illegible]@gmail	Farmer

NAME	Your City, State	Email	Affiliation
23. Noel Danner	Ariton AL	noeldanner@gmail.com	/Farmer
24. Chris Beaty	Dothan, AL	chrisbeaty@[illegible]	Farmer
25. Jim Waite	ANDAL,	jimrwaite@gmail.com	FARMER Reinke dealer
26. James Mock	Enterprise, Al	Jmdairy@gmail.com	Farm
27. Bobby Edmondson	Slocom Al	bobbyedmondson[illegible]@yahoo.com	Farmer
28. Dan Stokes	Elba, AL	jdanstokes@hotmail.com	Farmer
29. Denson Helms	Dothan, AL	dhelms@firstsouthland.com	First South Farm Credit
30. Kaitlyn McCurdy	Auburn, AL	kaitlyn.mccurdy@usda.gov	NRCS
31. Vernon Abney	Auburn, AL	Vernon.abney@usda.gov	NRCS
32. Garrett Skinner	Hartford, AL	garrettskinner0061@gmail.com	Farmer
33. Daniel Harpe	Cordele, GA	dth@tlirr.com	T-L Irrigation
34. Robert E. [illegible]	Hartford ala	RobertESKi[illegible]	Farmer
35. Glen E. Powell	Florala, AL	glenalh@gmail.com	Farmer
36. Joe I. Powell Jr.	Florala, AL		Farmer
37. Gary Cox	NewTon, AL	gary.cox@hcboe.us	Land owner
38. Kevin WARD	Brundidge	ward peanuts	Farmer
39. Joe Powell	Enterprise	ccattleco186mail	Farmer
40. Frank Albright	Elba, Al		Farmer
41. Terry Carpenter	Geneva Al		Farmer
42. Anthony Carpenter	Geneva, Al		Farmer
43. Stacy Sanders	Houston, AL		Farmer
44. Jeremy Brown	Clayton, AL	jdbrownfarms@gmail.com	Farmer
45. Robert Rands	Coffee Springs, AL	[illegible]@centurytel.net	Farmer
46. Randall Kyles	Enterprise AL	rkyles@firstsouthland.com	First South Sponsor

47. Michael Harper			OWR
48. Shae Holley			OWR
49. Jonathan Sanders	Roeton, AL		Farmer
50. LEWIS D HELMS	HEADLAND AL		OWNER-FARMER
51. Matt Singletary	HEADLAND, AL	mattsedsch20.com	Donald Smith Company
52. Matt Walker	Montgomery, AL	mwalker@alfafarmers.org	ALFA
53. NIGEL WELLS	OZARK, AL	NWELLS1945@GMAIL.COM	Farmer
54. Ricky Wilks	Kinston, AL		owner
55. Chris Day	Samson, AL	Christine515[illegible]@gmail.com	Owner
56. Clay Wise	Coffee Springs	wisefarms282@gmail.com	OWNer
57. J. Michael Riddle	Coffee Springs	jorfarm1@gmail.com	
58. Roger Dale Kirkland	Headland, Al	farmcedale@Gmail.com	
59. Anthony Reeves			Coffee Co SWCD
60. Josh Platt			NRCS
61. Carla Hornady		chornady@alfafarmers.org	Alfa
62. Courtney Smith		courtney@alconservationdistricts	AACD
63. Walt Ward			FARMER
64. Thomas Kirkland	TKirklandfarm@gmail.com	Headland AL	
65. Doris Skipper			
66. Steve Musser			NRCS
67. Sabra Sutton	Montgomery		AACD
68. Eve Brantley	Auburn, AL	brantley@auburn	AU/ACES
69. Rachel Koontz	Auburn, AL	rmk0011@au	ACES/AU
70. Cam Handy	UAH, AL	cameron.handyside@nsstc.uah.edu	UAH

Figure E-19: Sign-In Sheets for the August 20, 2019 Farmer Scoping Meeting in Enterprise, AL

ALABAMA SOIL & WATER CONSERVATION COMMITTEE

ALABAMA ASSOCIATION OF CONSERVATION DISTRICTS

Alabama Irrigation Initiative
Farmers Scoping Meeting
Choc-Pea Rivers Watershed
Agenda

DATE & TIME: August 20, 2019, 10 am-Noon
LOCATION: Enterprise Farmer's Market, 521 N. Main Street, Enterprise, AL 36330.

10:00 AM	**Welcome and Introductions**	Ms. Sabra Sutton, Executive Director, Alabama Association of Conservation Districts (AACD) Mr. Donnie Chasteen, Senator, State of Alabama District 29
10:15 AM	**ALII-The Process and Farmer Needs for Irrigation**	Discussion led by Dr. Eve Brantley, ACES
11:15 AM	**ALSWCC Cost-Share Process and Draft Timeline**	Ashley Henderson, PE, Director of Conservation Programs, Alabama Soil and Water Conservation Committee
11:45 AM	**Summary and Next Steps**	Dr. Bill Puckett, Executive Director, Alabama Soil and Water Conservation Committee
Noon	**Lunch**	Provided by: **First South Farm Credit**

Project Partners:

Alabama Agricultural Experiment Station
Alabama Association of Conservation Districts
Alabama Cooperative Extension Service
ALFA
Alabama Soil and Water Conservation Committee
Auburn University
Auburn University Water Resources Center
University of Alabama-Huntsville
USDA-Natural Resources Conservation Service

Figure E-20: Agenda for Farmer Scoping Meeting on August 20, 2019

L9454 Notice that a public meeting for comments will be held to review the United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), with assistance from Auburn University and in cooperation with the Alabama Soil and Water Conservation Committee Draft Watershed Plan-Environmental Assessment for the Choctawhatchee-Pea Watershed (Draft Plan - EA) to expand agricultural irrigation. This program may be partially funded through the Watershed Protection and Flood Prevention Act of 1954 (PL 83-566) and will address increasing irrigated acreage on agricultural land, while avoiding significant negative impact on the surrounding natural environment and cultural resources. The public meeting will be held 5:30-6:30 pm on November 6, 2019 at the Dale County Government Building, 202 South Hwy 123 Ozark, AL.

Affidavit of Publication of Legal Notice

State of Alabama

Houston County

Before me, a notary public in and for the county and state above listed, personally appeared Alice Trawick, who, by me duly sworn, deposes and says that:

"My name is Alice Trawick, I am the Legal Manager of the Dothan Eagle".

The Newspaper published the attached legal notice in the issues of:
10/27, 11/03/2019
Newspaper reference: 0001167798
The sum charged for publications was $290.00.

The charges by the Newspaper for said publication does not exceed the lowest actual classified rate paid by commercial customers for an advertisement of similar size and frequency in the same newspaper(s) in which the public notice appeared.
There are no agreements between the Newspaper and the officer or attorney charged with the duty of placing the attached legal advertising notices whereby any advantage, gain or profit accrued to said officer or attorney.

Alice Trawick
AFFIANT
Sworn and subscribed this 4 of November, 2019
Wendy Waid Allman
Notary Public State of Alabama

ALABAMA GREAT SEAL

OFFICIAL SEAL
WENDY WAID ALLMAN
Notary Public
Alabama State at Large
My Commission Expires April 24, 2023

Figure E-21: Affidavit for Announcement of Public Meeting

November 6th, 2019 Sign-In Sheet Ozark, AL

Sustainable Irrigation Expansion: *Public Meeting*

SIGN-IN SHEET

Name (Please Print)	Affiliation (if any)	How did you hear about this meeting? (Newspaper, direct invitation, etc.)	E-mail	*Would you like to be notified of future meetings and/or updates on the project?*
1. ADAM Z SCONYERS	NRCS + FARMER	DALE CO SWCD	adam.sconyers@usda.gov	email
2. Dawn Peters	Dale Co SWCD	SWCD	cynthia.peters@al.nacdnet.net	
3. Laura Bell	Auburn		laura.bell@auburn.edu	
4. Eve Brantley	AU	AU/ACES	brantley@auburn.edu	
5. Rachel Kuntz	AU			
6. Vernon Abney	NRCS		vernon.abn	
7. Will Puckett	SWCC			
8. Ashley Henderson	SWCC			
9. MARLON COOK	COOK HYDRO	A/U / ACES	COOKHYDROGEOLOGY@GMAIL.COM	

Figure E-22: Sign -In Sheet for the November 6, 2019 Public Meeting in Ozark, AL

Alabama Sustainable Irrigation Expansion
Public Law 83-566 Initiative
Public Meeting of the Choc-Pea Rivers Basin

Agenda

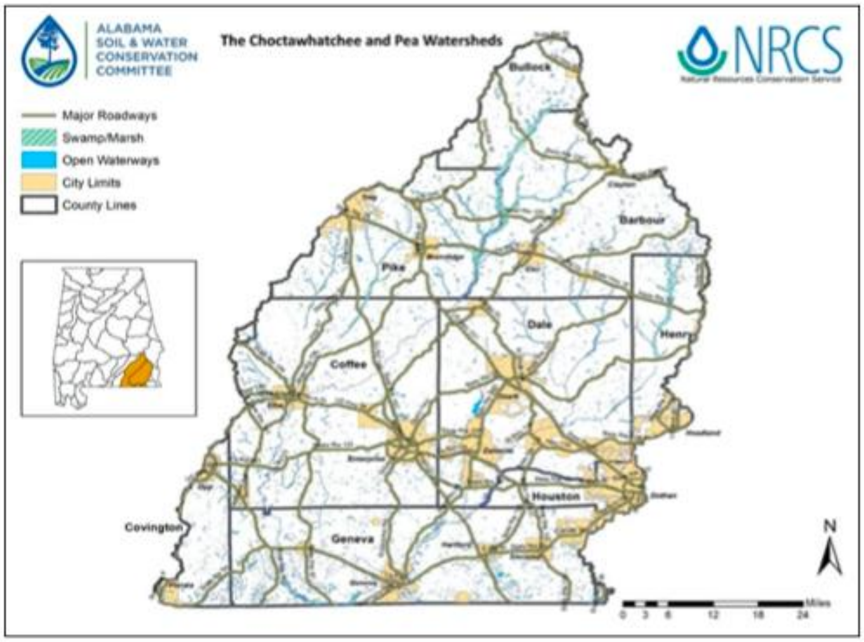
DATE & TIME: November 6, 2019, 5:30 pm – 6:30 pm
LOCATION: Dale County Government Building, 202 South Hwy 123, Ozark, AL

- 5:30 PM: **Welcome and Introductions**
  SWCC: Sponsoring Organization
  NRCS: Lead Federal Agency
  AU & UAH Team: Technical Team
  - **Project Summary and Purpose of Scoping**
    Program Overview & Process
- 6:00 PM: **Scoping Discussion and Comment Period**
- 6:30 PM: **Adjourn**

Project Partners:

Figure E-23: Agenda for Public Meeting on November 6, 2019

CHOC-PEA BASIN FACT SHEET



ABOUT THE REGION'S FARMER/AGRICULTURAL NEEDS

To better identify the particular needs of farmers in the Basin, a recent survey was conducted August 20, 2019 at a scoping meeting. Out of **41 respondents,**

- **85%** said there is "**extreme need**" for irrigation; the remaining 15% ranked the need at "much need".
    - Respondents provided reasoning for how they ranked the need for irrigation in the following statements: *"Recurrence of drought"; "Competition with Georgia"; "Improve crop production"; "Stability"; "Better production"; "Sandy soils"; "Necessary to survive farming"; "No rain"; "Low CEC soils cannot buffer low rainfall in growing season"; "Lack of irrigation"; "Insurance premium cuts, profit margins too close, diversified crops"; "Peace of mind"; "Reduce risk, increase production, minimize drought impact, increase productivity, and reduce waste."*

- **88%** of respondents said they were "**extremely interested**" in expanding irrigation in their area; the remaining 12% ranked their interest as "very interested".
    - Respondents provided the following statements as reasoning behind their choices: *"it would help greatly with production"; "Less than 1/5 under irrigation"; "Need better productivity"; "More profit."*

1

Figure E-24: Fact Sheet Offered at Public Meeting (Page 1)

PURPOSE OF THIS PROJECT

- The purpose of this project is to develop diffuse, or decentralized, on-farm irrigation systems suitable for the farming practices in the Choc-Pea Basin that adhere to State and Federal law and sustainably use water systems.
- Federal assistance through PL-566 is needed to support the modernization and sustainability of agricultural production in this region.
- Modernizing irrigation methods can help minimize crop losses due to drought, supplement soils with poor water holding capacity during periods of uneven rainfall distribution, improve recovery of water-stressed systems, and support current agricultural land use.

IRRIGATION WATERSHED PLANNING PROCESS (PL-566)

Prelinary Investigation

↓

Feasibility Report

↓

Plan of Work

↓

Watershed Plan- Environmental Assessment (EA)

↓

Environmental Evaluations

ESTIMATED TIMELINE

(2019) *(2020)*

July – October

Scoping Process

- Preliminary Investigation

November

Determine Feasibility & Project Works

- Feasibility Report
- Plan of Work

December-March

Modeling Impacts and Drafting Plan

- Draft Plan-EA Completed

Post March 1

Review Process

- Receive and incorporate comments from NWMC
- Update Draft Plan

CONTACT US

If you have any questions or would like to provide comments/input, please contact any of the following people:

- Ashley Henderson - ashley.henderson@swcc.alabama.gov
- Eve Brantley - brantef@auburn.edu
- Vernon Abney - Vernon.abney@usda.gov

Learn more about this Initiative's past and present projects at:

http://cses.auburn.edu/irrigation-watershed-planning/watersheds/

2

Figure E-25: Fact Sheet Offered at Public Meeting (Page 2)

DC Meeting- July 11, 2019

List of Attendees	Affialiation- Region
Patricia Gunter	SWCD-Covington
Allison O'Neal	SWCD-Covington
Richard Collier	NRCS- East Team
Dawn Peters	SWCD-Dale
Adam Sconyers	NRCS-- Dale/Henry
Dorris Skipper	SWCD-Coffee
Ashley Henderson	ALSWCC- Montgomery
William Puckett	ALSWCC- Montgomery
Josh Elliot	NRCS- Coffee/Covington
Jennifer Williams	SWCD- Pike
Jeff Thurmond	NRCS-State
Shannon Weavor	NRCS-State
Beth Chastain	NRCS- Crenshaw
Karron Passmore	SWCD-Russell
Jessica Jones	SWCD-Crenshaw
Carol Threatt	SWCD-Barbour
Rachel Kuntz	Auburn University, ACES- Lee
Bethanie Hartzog	Auburn University, ACES- Lee
Cameron Handyside	UAH

Figure E-26: Sign-In Sheet for July 11,2019 SWCD Meeting in New Brockton, AL

Fw: Reminder, October 30, Choctawhatchee-Pea Watershed Planning Meeting

Subject: Reminder, October 30, Choctawhatchee-Pea Watershed Planning Meeting

The Alabama NRCS and partnering technical team will hold a meeting on October 30 in Montgomery, Alabama to request input on the Choctawhatchee-Pea Watershed Plan. A Watershed Plan will be prepared to fulfill requirements for federal financial assistance to sustainably expand agricultural irrigation through the Watershed Protection and Flood Prevention Program (Public Law 83-566).

Time:
10 am-noon - Choctawhatchee Pea Watershed Plan Stakeholder Meeting
1 pm - 2 pm - Middle Tennessee River Watershed Plan Update

Location:
RSA Union Building
Room 192, Division of Purchasing
100 North Union Street
Montgomery, Alabama

Parking Deck Code 402005
If you are not able to participate in this meeting, we will meet with you individually or in planned group meetings to discuss interests, recommendations or concerns your organization may have regarding this project.

Topics for the meeting include:

1) present a summary of the recent farmer scoping meeting in Enterprise,

2) seek input on initiatives, available data, concerns and recommendations for the Choctawhatchee-Pea Watershed as we begin the planning process, and

3) share updates from the Middle Tennessee River Basin Watershed planning project.

If you have any questions or comments, please contact Eve Brantley at brantley@auburn.edu and Vernon Abney at vernon.abney@al.usda.gov. We encourage and value your participation and input.

Sincerely,

Eve Brantley
brantley@auburn.edu

Figure E-27: E-mail Sent to Cooperating Agencies

Oct 30, 2019

Sustainable Irrigation Expansion: Partnering Agency Meeting

Name (Please Print)	Affiliation	E-mail	Would you like to be notified of future meetings and/or updates on the project?
1. Rachel Kuntz	AU/ACES	rachel.kuntz@yahoo.com	yes
2. Eve Brantley	AU/ACES	brantley@auburn.edu	yes
3. Laura Bell	AU/ACES	laura.bell@auburn.edu	yes
4. Doris Skipper	SWCD	coffee@alconservationdistrict.org	Yes
5. Josh Elliott	NRCS	joshua.elliott@usda.gov	Yes
6. Annie Blankenship	NRCS	annie.blankenship@usda.gov	yes
7. Barbara Gibson	CPYRWMA	choctaw@troy.edu	yes
8. John Curtis	NRCS	John.Curtis@usda.gov	yes
9. Tom Littlepage	ADECA OWR	tom.littlepage@adeca.alabama.gov	Yes
10. BRIAN ATKINS	ADECA-OWR	BRIAN.ATKINS@ADECA.ALABAMA.GOV	Yes
11. Jennifer Grunewald	USFWS	jennifer_grunewald@fws.gov	Yes
12. Vernon Abney	NRCS	vernon.abney@usda.gov	Yes
13. Greg Guthrie	AL Geol Survey	gguthrie@gsa.state.al.us	Yes
14. Marissa Chavez	SWCD		
15. Colleen Lewis	SWCD		

Figure E-28: Sign-In Sheet for October 30, 2019 Agency Meeting In Montgomery, AL (Page 1)

Oct. 30, 2019

Name (Please Print)	Affiliation	E-mail	Would you like to be notified of future meetings and/or updates on the project?
16. Chris Johnson	ADEM	cljohnson@adem.alabama.gov	Yes
17. MARLON COOK	COOK HYDRO	COOKHYDROGEOLOGY@GMAIL.com	YES
18. Lindsay McDonald	City of Dothan	lmcdonald@dothan.org	yes
19. Henry "Hank" Mosley	Dothan	hmosley@dothan.org	Yes
20. David Adams	NRCS	david.adams1@usda.gov	Yes
21. Stuart McGregor	GSA	smcgregor@gsa.state.al.us	Yes
22. Michael Mullen	Choctawhatchee Riverkeeper	riverkeeper@troycable.net	Yes
23. Alex Vaughan	NRCS		
24. Amanda McBride	AHC	amanda.mcbride@ahc.alabama.gov	Yes
25. Eric Sipes	AHC	Eric.Sipes@AHC.alabama.gov	Yes
26. BEN MALONE	NRCS		
27. Bob Plester	AGI	bob.plester@agi.alabama.gov	Yes
28. M.H. Walker	ALFA	mwalker@alfafarmers.org	yes
29. Mitch Reid	TNC	mitchell.reid@tnc.org	yes
30. Ann Arnold	GSA	aarnold@gsa.state.al.us	yes
31. MAURY ESTES	UAH	MAURY.ESTES@NSSTC.UAH.EDU	Y

Figure E-29: Sign-In Sheet for October 30, 2019 Agency Meeting in Montgomery, AL (Page 2)

Oct. 30, 2019

Name (Please Print)	Affiliation	E-mail	*Would you like to be notified of future meetings and/or updates on the project?*
32. Krel Haynes	UAH	Keh0018@uah.edu	Y
33. Jonathan Beeson	UAH	jdb0070@uah.edu	Y
34. Lucal Alonso Guzman	UAH	llg0009@uah.edu	Y
35. Kevin Doty	UAH	kevin.doty@nsstc.uah.edu	Y
36.			
37.			
38.			
39.			
40.			
41.			
42.			
43.			
44.			
45.			
46.			
47.			

Figure E-30: Sign-In Sheets for October 30, 2019 Agency Meeting in Montgomery, AL (Page 3)

Alabama Sustainable Irrigation Expansion
Public Law 83-566 Initiative
Partner Agency Meeting of the Choc-Pea Rivers Basin

Agenda

DATE & TIME: October 30, 2019, 10:00 am – 2:00 pm
LOCATION: 100 North Union Street Montgomery, AL, Room 192

- 10:00 AM: **Welcome and Introductions**
  SWCC: Sponsoring Organization
  NRCS: Lead Federal Agency
  AU & UAH Team: Technical Team
  - **Project Summary and Purpose of Scoping**
    Program Overview & Process
  - **Post-Planning Process**
    Explanation of Tech Note 1; Process and Ranking
  - **Importance of Data**
    Overview of current data being used, and data still needed
- 10:45 AM: **Scoping Discussion and Comment Period**
- 12:00 PM: **Lunch (on your own)**
- 1:00 PM: **Update of Middle TN River Valley Watershed Plan (Optional)**
- 2:00 PM: **Adjourn**

Project Partners:

Figure E-31: Agenda for Agency Meeting on October 30, 2019

Table E-1. Irrigation Practice Effects on T&E Species

Code	Practice	Unit	Practice Effects				Comments
			No Effect	Not Likely to Adversely Affect T&E Species	MA	NLAA, B	
441	Irrigation System, Microirrigation	ac	N				
442	Irrigation System, Sprinkler	ac	N				
443	Irrigation System, Surface and Subsurface	ac	N				
430	Irrigation Water Conveyance	ft		Avoid crossing streams with this practice.			If pipeline crosses a stream, contact NRCS Biologist to determine if consultation is necessary.
449	Irrigation Water Management	ac	N				
533	Pumping Plant	no		If the practice will be placed within 50 feet of a stream within a 12-digit HUC containing T&E aquatic species, further investigation is required. Increase buffer distance as needed to maintain the ecological and structural integrity of the riparian buffer and stream bank. If the practice will be placed in a habitat type where a threatened or endangered species may reside AND if disturbance of native vegetation (changing land use, herbicide		If this practice improves water quality and/or quantity, then this practice is beneficial for aquatic species.	Contact State Biologist to determine if consultation is necessary. Can be beneficial to aquatics if replacing surface water withdrawals at critical times.

Table E-1. Irrigation Practice Effects on T&E Species

Code	Practice	Unit	Practice Effects				Comments
			No Effect	Not Likely to Adversely Affect T&E Species	MA	NLAA, B	
				application, earthmoving, soil disturbance, etc.) is involved in the installation of this practice, further investigation is required. Review the Sensitive Habitat Fact Sheet and plant fact sheets. Make a visual observation of the area to determine if the species or habitat for the species exists.			
642	Water Well	no		If the practice will be placed in a habitat where a threatened or endangered species may reside, further investigation is required. Review the Sensitive Habitat Fact Sheet, then make a visual observation of the area to determine if the species or habitat for species exists. Examples include: Avoid ground disturbing activities within Red Hills Salamander habitat; Avoid altering hydrology of ephemeral drains (avoid logging during wet weather) within the FWS habitat. If the practice will be placed in a habitat type where a threatened or endangered species may reside AND if disturbance of native vegetation (changing land use, herbicide application, earthmoving, soil disturbance, etc.) is involved in the installation of this practice, further		If this practice improves water quality and/or quantity, then this practice is beneficial for aquatic species.	Benefits to aquatics apply if this practice results in stream exclusion.

Table E-1. Irrigation Practice Effects on T&E Species

Code	Practice	Unit	Practice Effects				Comments
			No Effect	Not Likely to Adversely Affect T&E Species	MA	NLAA, B	
				investigation is required. Review the Sensitive Habitat Fact Sheet and plant fact sheets. Make a visual observation of the area to determine if the species or habitat for the species exists.			

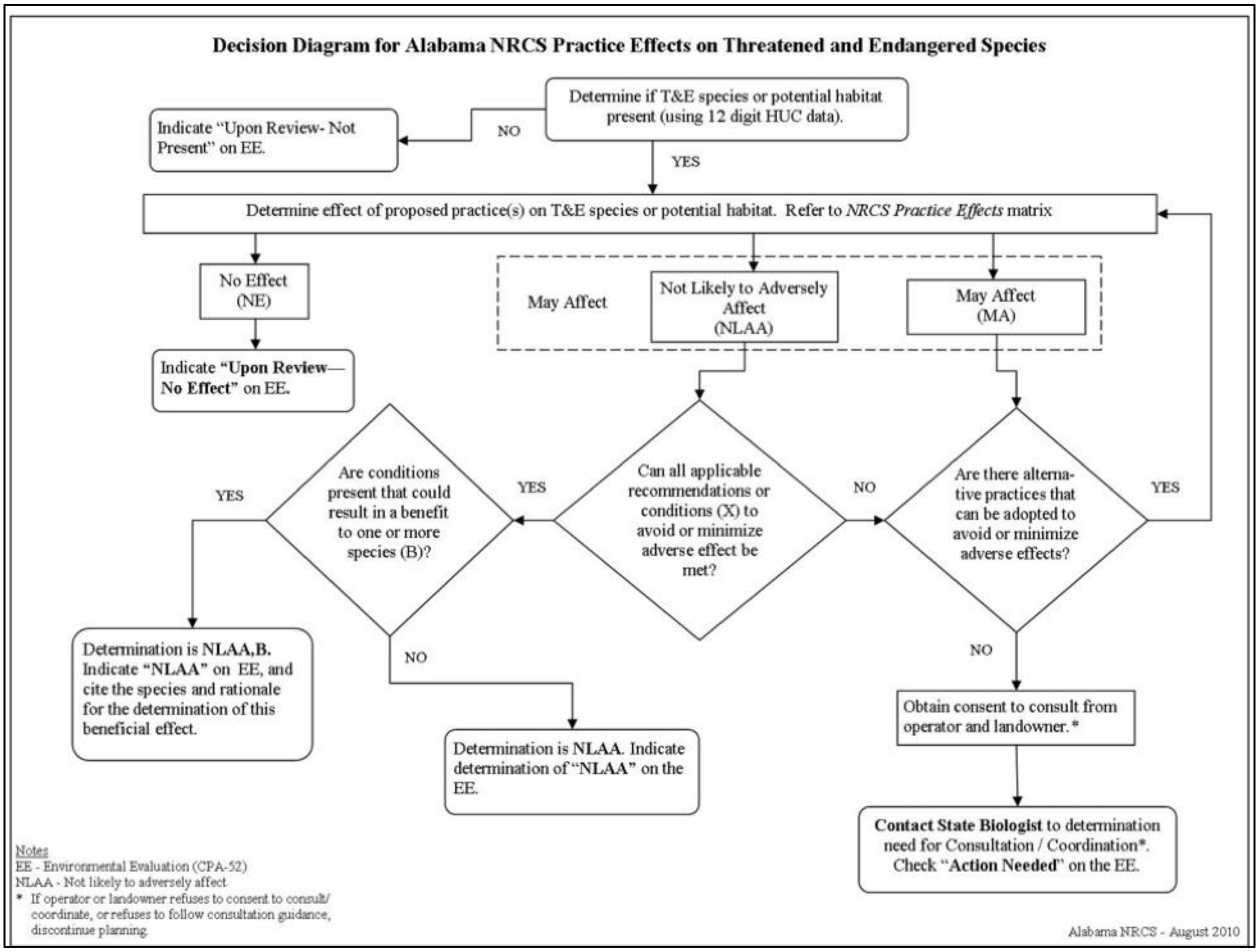


Figure E-32: Decision Diagram for NRCS Practice Effects on T&E Species

Table E-2. Typical Farmer Application Ranking Criteria[1]

Farmer Application Ranking Criteria
Is this the primary application for this program?
Field to be irrigated has current conservation plan with installed conservation practices.
Current tillage method resulted in >= 30% residue on the field to be irrigated
Single species cover crop currently used on the field to be irrigated
Multi-species cover crop currently used on the field to be irrigated
Field has water source developed and ready for hookup to planned irrigation system
Field has water source identified but not developed or ready for hookup to planned irrigation system
Power is available and ready for hookup to planned irrigation system
Distance to water source, < 1/2 mile
Distance to water source, > 1/2 and < 1 mile
Distance to water source, >= 1 mile
If water source for irrigation is a stream, less than 10% of HUC-12 watershed land area is irrigated
No permits (i.e., USCOE, USFWS, ADEM) are required for planned irrigation system, except for Office of Water Resources' Certificate of Use.
Field not limited on irrigation general table in Soil Survey
Field is somewhat limited on irrigation general table in Soil Survey
Field is very limited on irrigation general table in Soil Survey
TOTAL POINTS

[1] This table does not include the specific scores pertaining to each issue but does show the subject matter the SLO will use for the ranking process to more accurately ensure unbiased, accurate farm information submitted in applications.

United States Department of Agriculture

NRCS Natural Resources Conservation Service

3381 Skyway Drive
Auburn, AL 36830
(334) 887-4561

EXCERPT – Refer to NRCS Field Office Technical Guide for entire document

Conservation Practice Classification of Effects for

Cultural Resources

(NG, PG or G Ratings)

If a practice is classified or rated PG (**P**otentially **G**round disturbing) and will be disturbing new ground or is rated G (**G**round disturbing), the Cultural Resources Review (CRR) form must be sent to the Cultural Resources Specialist (CRS) for further review. Exceptions to this required review by the CRS for some PG practices are footnoted with explanations below.

All management – related practices that are rated NG (**N**ot **G**round disturbing) however include facilitating G or PG practices within the standard will require a review by the CRS.

ALL Cultural Resources Reviews for AWEP, EWP and Easement Programs (e.g. FRPP, GRP, WRP), will be forwarded to the CRS for further review *regardless of the practice rating or classification* of effect (NG, PG or G).

Always contact the CR specialist if a cultural resource will be affected in any way (positively or negatively) as a result of federal assistance.

If any artifacts or archaeological features are encountered during (or after) practice installation, work shall cease, and the CRS shall be notified immediately. If the CRS is not available, contact the Cultural Resources Coordinator.

Practice Name	Practice Number	Rating
Critical Area Planting	342	PG
Dam	402	G
Irrigation Canal or Lateral	320	G
Irrigation Ditch Lining	428	NG
Irrigation Field Ditch	388	G
Irrigation Land Leveling	464	G
Irrigation Pipeline	430	G
Irrigation Storage Reservoir	436	G
Irrigation System – Micro-irrigation	441	PG
Irrigation System, Sprinkler	442	PG
Irrigation System, Surface and Subsurface	443	G
Irrigation System, Tailwater Recovery	447	PG
Irrigation Water Management	449	NG
Land Clearing	460	G
Land Smoothing	466	G
Lined Waterway or Outlet	468	PG
Monitoring Well	353	G
Pond	378	G
Pumping Plant	533	G
Water Harvesting Catchment	636	G
Water Well	642	G

eFOTG Section II

Figure E-33: NRCS Conservation Practice Classification of Effects for Cultural Resources

CULTURAL RESOURCES REVIEW: ________________ COUNTY

1. Owner /Farm Tract No. ______________________________ Start Date __________

2. Program/CTA: __________ Practice Codes ______________________________

3. PRESENT Land Use: Crops/Plowed ☐ Grass ☐ Trees ☐ Fallow ☐ Clear-Cut ☐

Exposed/Eroded ☐ Wetland ☐ Other ______________________________

4. APE: ________ Acres/Ft **5.** ________ Acres of APE inspected **6**. APE Surface Visibility______%

The APE (*Area of Potential Effect*) is the **specific** area affected by program/practice, including all new or existing borrow/disposal areas, new or temporary access roads & any other off-site or indirect ground-disturbing activities.----- **NOTE**: If artifacts are discovered during practice construction, stop work in the immediate area and contact CRS for guidance. If artifacts discovered after completion, contact CRS ASAP.

7. Information Sources: FO Inspection of APE ☐ Landowner/User ☐ AFC ☐

Other ______________________________ **8.** ACROD site file search date__________

9. Are any Cultural Resources in/within 100ft of the **APE?** ***NO*** ☐ ***YES*** ☐

If YES -- Artifacts Reported by FO/owner/others? ☐ Site **deliberately** avoided during planning? ☐

10. Will the practice(s) exceed the depth & extent of previous cultivation? ***YES*** ☐ ***NO*** ☐

11. IF a site is in or near the APE OR any practice is PG or G **SEND to the CRS for further review**

OR

IF there are **NO sites** ***AND*** **NO PG or G** Practice, NO review by the CRS is required. Sign & File at the FO.

12. CR Review Completed by: ______________________________ **Date** __________

13. FO Comments: ______________________________

______________________________ **14.** Date **PRS** data added ______________

15. Township: __________ Range: __________ Section(s) ______________

To be Completed by the CRS

CRS Contacted / Form Rec'd __________ Site File Check date __________ Site(s): **NO**

YES: ______________________ ☐ Avoided ☐ Ineligible **NO EFFECT** ☐

CRS Comments ______________________________

____

______________________________ Site Probability: High Medium Low

CRS will survey ASAP ☐ at a later date ☐ Recommends **FO inspect** after practice installation ☐ and report to CRS if artifacts observed.

Date(s) Surveyed by CRS ______________________ **Date APE inspected by FO** __________

CRS ______________________________ Date ______________

Entered into PRS by CRS __________ Scanned/Copied to FO ________

Revised 1/16/2019

Figure E-34: Cultural Resources NRCS Review Form

U.S. Department of Agriculture Natural Resources Conservation Service **ENVIRONMENTAL EVALUATION WORKSHEET**	NRCS-CPA-52 11/2019	A. Client Name:
		B. Conservation Plan ID # (as applicable): Program Authority (optional):
D. Client's Objective(s) (purpose):		C. Identification # (farm, tract, field #, etc. as required):

E. Need for Action:	H. Alternatives					
	No Action	√ if RMS	*Alternative 1*	√ if RMS	*Alternative 2*	√ if RMS

Resource Concerns

In Section "F" below, analyze, record, and address concerns identified through the Resources Inventory process.
(See FOTG Section III - Resource Planning Criteria for guidance).

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. Effects of Alternatives					
	No Action		*Alternative 1*		*Alternative 2*	
	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC
SOIL						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
WATER						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC

Figure E-35: NRCS CPA-52 Environmental Evaluation Worksheet (Page 1)

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. (continued)					
	No Action		***Alternative 1***		***Alternative 2***	
	Amount, Status, Description *(Document both short and long term impacts)*	**√ if does NOT meet PC**	**Amount, Status, Description** *(Document both short and long term impacts)*	**√ if does NOT meet PC**	**Amount, Status, Description** *(Document both short and long term impacts)*	**√ if does NOT meet PC**
AIR						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
PLANTS						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
ANIMALS						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
ENERGY						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
Human Economic and Social Considerations						

Figure E-36: NRCS CPA-52 Environmental Evaluation Worksheet (Page 2)

Special Environmental Concerns: Environmental Laws, Executive Orders, policies, etc.						
In Section "G" complete and attach Environmental Procedures Guide Sheets for documentation as applicable. Items with a "▪" may require a federal permit or consultation/coordination between the lead agency and another government agency. In these cases, effects may need to be determined in consultation with another agency. Planning and practice implementation may proceed for practices not involved in consultation.						
G. Special Environmental Concerns (Document existing/ benchmark conditions)	J. Impacts to Special Environmental Concerns					
	No Action		Alternative 1		Alternative 2	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
▪Clean Air Act Guide Sheet		☐		☐		☐
▪Clean Water Act / Waters of the U.S. Guide Sheet		☐		☐		☐
▪Coastal Zone Management Guide Sheet		☐		☐		☐
Coral Reefs Guide Sheet		☐		☐		☐
▪Cultural Resources / Historic Properties Guide Sheet		☐		☐		☐
▪Endangered and Threatened Species Guide Sheet		☐		☐		☐
Environmental Justice Guide Sheet		☐		☐		☐
▪Essential Fish Habitat Guide Sheet		☐		☐		☐
Floodplain Management Guide Sheet		☐		☐		☐
Invasive Species Guide Sheet		☐		☐		☐
▪Migratory Birds/Bald and Golden Eagle Protection Act Guide Sheet		☐		☐		☐
Natural Areas Guide Sheet		☐		☐		☐
Prime and Unique Farmlands Guide Sheet		☐		☐		☐
Riparian Area Guide Sheet		☐		☐		☐
Scenic Beauty Guide Sheet		☐		☐		☐

Figure E-37: NRCS CPA-52 Environmental Evaluation Worksheet (Page 3)

• Wetlands *Guide Sheet*		☐		☐		☐
• Wild and Scenic Rivers *Guide Sheet*		☐		☐		☐

K. Other Agencies and Broad Public Concerns	***No Action***	***Alternative 1***	***Alternative 2***
Easements, Permissions, Public Review, or Permits Required and Agencies Consulted.			
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)			
L. Mitigation (Record actions to avoid, minimize, and compensate)			
M. Preferred Alternative – √ preferred alternative	☐	☐	☐
M. Preferred Alternative – Supporting reason			

N. Context (Record context of alternatives analysis)

The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.

O. To the best of my knowledge, the data shown on this form is accurate and complete:

In the case where a non-NRCS person (e.g. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block to verify the information's accuracy.

Signature (TSP if applicable)	**Title**	**Date**
Signature (NRCS)	**Title**	**Date**

If preferred alternative is not a federal action where NRCS has control or responsibility and this NRCS-CPA-52 is shared with someone other than the client then indicate to whom this is being provided.

The following sections are to be completed by the Responsible Federal Official (RFO)

NRCS is the RFO if the action is subject to NRCS control and responsibility (e.g., actions financed, funded, assisted, conducted, regulated, or approved by NRCS). These actions do not include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance and situations where NRCS is making a technical determination (such as Farm Bill HEL or wetland determinations) not associated with the planning process.

P. Determination of Significance or Extraordinary Circumstances

To answer the questions below, consider the severity (intensity) of impacts in the contexts identified above. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.

Yes	No	
☐	☐	• Is the preferred alternative expected to cause significant effects on public health or safety?
☐	☐	• Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?
☐	☐	• Are the effects of the preferred alternative on the quality of the human environment likely to be highly
☐	☐	• Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?
☐	☐	• Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?
☐	☐	• Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?
☐	☐	• Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.
☐	☐	• Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?

Figure E-38: NRCS CPA-52 Environmental Evaluation Worksheet (Page 4)

Q. NEPA Compliance Finding (check one)

The preferred alternative:		Action required
☐	1) is **not a federal action** where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action **ALL** of which is **categorically excluded** from further environmental analysis **AND** there are **no extraordinary circumstances as identified in Section "O".**	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been **sufficiently analyzed** in an existing Agency state, regional, or national NEPA document **and** there are no predicted significant adverse environmental effects or extraordinary circumstances.	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects **and has been formally adopted by NRCS**. NRCS is required to prepare and publish its own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. **(Note: This box is not applicable to FSA)**	Contact the State Environmental Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
☐	5) is a federal action that has **NOT** been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Liaison. Further NEPA analysis required.

R. Rationale Supporting the Finding

R.1 Findings Documentation	
R.2 Applicable Categorical Exclusion(s) **(more than one may apply)**	
7 CFR Part 650 *Compliance With NEPA*, subpart 650.6 *Categorical Exclusions* states prior to determining that a proposed action is categorically excluded under paragraph (d) of this section, the proposed action must meet six sideboard criteria. See NECH 610.116.	

I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy and based on that made the finding indicated above.

S. Signature of Responsible Federal Official:

Signature	Title	Date

Additional notes

Figure E-39: NRCS CPA-52 Environmental Evaluation Worksheet (Page 5)